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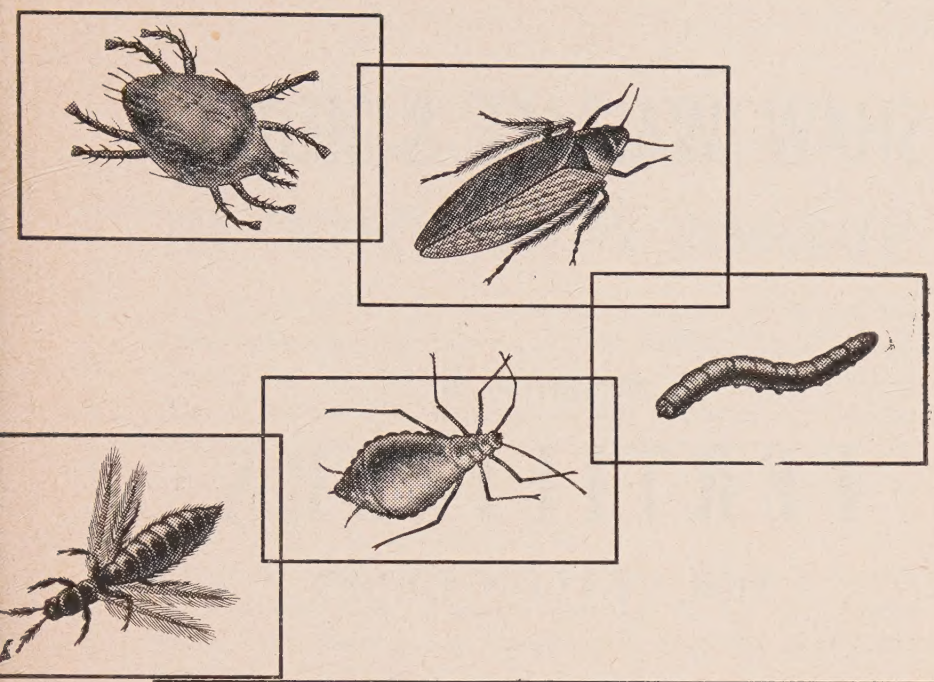

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EDITORIAL

Subsidiary Food Crops

THE Committee appointed recently by Government to study certain aspects of the cost-of-living problem in Ceylon reports that subsidiary food items such as pulses, potatoes, onions and chillies figure very prominently in the household budget of the average Ceylon family, and that they will have to be made available at reasonably low prices if any substantial reduction in the cost of living in Ceylon is to be effected by Government. Ceylon's annual imports of dry chillies, onions, potatoes and pulses, which have increased considerably in recent years, drain away over 45 million rupees in foreign exchange. Except in the case of red onions, domestic production meets only a negligible fraction of the Island's requirements of these commodities so widely used in practically every Ceylonese home. Even in the case of red onions, the island's requirements have to be imported from India each year for about three months during the North East Monsoon period when owing to the heavy rains yields are low. This would also be hardly necessary if the difficulties experienced in storing sufficient quantities of onions produced during the peak season without loss of weight and quality through excessive driage and sprouting are overcome.

In the past several attempts have been made to induce farmers, particularly in the dry zone, to undertake large-scale cultivation of chillies and onions. However, there has been no appreciable increase in the production of dry chillies. Although the *Wanni* villager has been cultivating chillies as a *chena* crop, the varieties grown do not produce a cured product that compares favourably in quality with the Tuticorin chilli.

Tuticorin chilli is a crop that requires intensive cultivation for success. In the Jaffna peninsula, Tuticorin chillies are raised in small irrigated plots in rotation with the other crops, and the yields average over 12 cwt. per acre due to the very high standard of cultivation. However, the spread of the chilli leaf-curl complex caused by virus, thrip and mite attacks in recent years has proved a major obstacle

to extended cultivation of chillies. Trials now in progress to select varieties resistant to leaf curl show promise although the new resistant selections lack the pungency of the Tuticorin chilli and take a day or two longer to dry. It is hoped that in the near future selections of high quality resistant to leaf curl will be available for large-scale cultivation.

However, with the restriction of imports of these commodities to conserve foreign exchange, it becomes necessary for local production to be stepped up immediately. In regard to potato, this number of the *Tropical Agriculturist* clearly indicates the vast potentialities for local production. Dr. Pushkaranath, whose final report is published in full in this number, has clearly shown that the expansion of Ceylon's potato acreage is now more a managerial problem than a technical one. With the progress made in the production of the requirements of quality seed potatoes and the development of satisfactory cultivation techniques, it should be possible to ensure the cultivation of the required acreage in the areas defined as suitable for the production of the crops without the hazards of bacterial wilt and other troublesome diseases.

Prospects for dry chilli production on a large scale are however not so bright at present in view of the low margin of profit and the high requirements of labour both for cultivation and for harvesting. Cultivators prefer to pick chillies green because of the prevailing high prices for green chillies, which when dried produce only one third by weight of dry chillies. They believe that early picking stimulates the production of more chillies by the plant. There is however little doubt that well drained paddy land in the dry zone that does not receive adequate quantities of irrigation water for rice during the *Yala* season can be deployed for raising chillies and onions which require less water than rice ; but it is not so certain whether attempts to cultivate large units of 1,000 acres and over will be a success as the problem of finding the necessary labour at the appropriate time will present serious difficulties. Even if the preparatory tillage, planting and inter-cultivation are mechanised it would still be necessary for harvesting to be done by hand. Therefore, it seems that the most prudent approach is to encourage individual farmers to cultivate under irrigation small extents that can be managed by the family itself, and to ensure that the necessary acreage is made up by such small individual units. Financial assistance in the form of a subsidy for the construction of wells in highland allotments would be an incentive to increased production of these subsidiary food crops.

It is well to remember that the cultivation of chillies and onions in paddy fields is not an economic proposition in *Maha* because of the excessive wet soil conditions in the tract, and that even in *Yala* these crops can only be cultivated in a section of the paddy area in which the soil is friable and well drained. Nevertheless there is no reason why self-sufficiency in these subsidiary food crops should not be achieved in the near future. It is only necessary to wean the *Wanni* cultivator from his traditional dependence on paddy as the sole crop to be grown under irrigation.

Report of Dr. Pushkarnath, M.Sc., Ph.D., Assoc. I.A.R.I., Director, Central Potato Research Institute, Simla, on the Potato Development Project in Ceylon *

INTRODUCTION

I last visited Ceylon in the latter part of March, 1958. I visited the Island again in February, 1960, to advise the Ceylon Government on the organisation of the Potato Project initiated in 1959.

In 1951-52 some organised attempts to introduce the potato in the country had been made by the Department of Agriculture, Ceylon. These efforts, however, did not succeed. Heavy expenditure was incurred on the Rahangala project which had to be subsequently closed down. Again, the schemes of the Department of Food Production to popularise the cultivation of potatoes in the villages proved abortive. Large quantities of seed potatoes issued for planting under the scheme could not be recovered owing to crop failure. (Richards, 1958†). At the time of my visit in 1958 the chances of commercialization of potato in the Island were considered to be very bleak. A sense of pessimism prevailed even among otherwise enthusiastic workers. It, however, appeared to me that lack of appreciation of the problems involved and inexpert handling of the crop were the main factors which led to these rather sad experiences.

In 1958 the work had to be accomplished under unavoidable limitations. The needed information regarding climatic and cultural conditions, etc., was hardly available. I had to base my conclusions on the fragmentary data I could secure from the departmental officers and a few published meteorological reports. In 1958, therefore, it was not possible to give, in my earlier report, more than a broad outline of the programme to be initiated in the country.

*Based on his visit to Ceylon between 5th February to 3rd March, 1960, under the Technical Co-operation Scheme of the Colombo Plan.

†Richards, A. V. (1958). Cultivation of Potatoes in Ceylon. Tropical Agriculturist. Vol. CXIV, No. 2.

The effective manner in which, Dr. M. F. Chandraratna, Mr. A. V. Richards and their associates have pursued the programme drawn up during my first visit in 1958 deserves my sincere appreciation. Their conviction and will behind the project have yielded results of lasting nature. Although the project has just begun, a year's work has elevated the potato to a respectable place in the departmental plans of development. It has infused confidence, not only in the workers but also among the cultivators who have, from time to time, received and grown the seed potatoes produced locally by the Department of Agriculture. With further technical assistance that has now been made available to the department, the potato is bound to establish itself as a chief cash and a food crop in the hill regions of this Island.

Some useful data are now available to deal, in a more comprehensive way, with several problems (existing and those likely to arise) connected with Potato Development and Research in Ceylon. I propose to deal with the subject under the following four heads :

1. Prospects of potato cultivation in Ceylon.
2. Problems of potato culture in Ceylon.
3. Extension and marketing of potatoes in Ceylon.
4. Organisation of potato research and development in Ceylon.

Several suggestions for strengthening the research and development organisations of the Potato Project have been given in the report.

ACKNOWLEDGMENT

In accomplishing my work I have received valuable support from Dr. M. F. Chandraratna, Director of Agriculture and Mr. A. V. Richards Deputy Director of Agriculture. I am extremely grateful to them. Dr. D. V. W. Abeygoonewardena and Mr. R. Wijesooriya have been very helpful to me in my field work. I wish to place on record my appreciation for the good work they have done.

I also wish to acknowledge the help I received in carrying out the task assigned to me, from the Indian High Commission in Ceylon.

SECTION I

PROSPECTS OF POTATO CULTIVATION IN CEYLON

1. EXISTING SOURCES OF SUPPLY

2. FOOD VALUE AND CONSUMPTION, PER CAPITA

3. TECHNOLOGICAL POTENTIALITIES

   (*a*) Temperature

   (*b*) Photoperiod

   (*c*) Rainfall

   (*d*) Soil

4. CONCLUSIONS

EXISTING SOURCES OF SUPPLY

First attempts at growing potatoes were made in about 1850 at Nuwara Eliya by Sir Samuel Baker*. The potato appears to have been grown, in a limited way, in the country for over 100 years. For several decades cultivators in the hilly areas have been growing a potato, *Solanum Commersonii*, originally imported from Uruguay. I have examined the crops of this potato. It is a variety of *S. tuberosum* belonging to sub-species *andigenum*. It has purple, irregularly shaped tubers of very low commercial value. The produce hardly finds its way into trade channels and is mostly consumed locally. The country is dependent on foreign imports for its domestic needs. Annual imports of potato in 1958 were 865,037 cwt., i.e., 43,250 tons valued at over Rs. 16,600,000. Monthly import figures are given in the table below :

TABLE I

Monthly Imports of potatoes into Ceylon during 1959 †

Month	*Quantity in Cwt.*	*Value in rupees*	*Percentage Total*
January	117,427 ..	2,299,562 ..	13·6
February	65,155 ..	1,142,088 ..	7·5
March	43,459 ..	772,218 ..	5·0
April	87,732 ..	1,651,863 ..	10·1
May	45,088 ..	924,649 ..	5·2
June	34,273 ..	696,361 ..	4·0
July	53,677 ..	1,089,947 ..	6·2
August	79,966 ..	1,643,183 ..	9·2
September	73,537 ..	1,368,864 ..	8·5
October	57,806 ..	1,045,873 ..	6·7
November	113,624 ..	2,156,663 ..	13·1
December	93,329 ..	1,837,320 ..	10·9
Total ..	865,037	16,628,591	100·0

The imports are from very varied sources, namely, Kenya, the British Possessions in Africa, Tanganika, India, the Republic of China,

*Baker, S. (1895). " Eight years in Ceylon " published by Longman's Green & Co.

† Ceylon Customs Returns 1958. Govt. Press, Ceylon.

Egypt, Belgium, France, Iran, Italy, Japan and the Netherlands. The bulk of the annual requirements is secured from the Netherlands, Italy, Egypt and France. The inflow of potatoes, either for seed purposes or for table use, is regular and steady throughout the year. It is somewhat higher during the months of November, December and January, when a part of the imports finds use as seed in the hill areas.

The wholesale price level varied from Rs. 400 to Rs. 572.60 per ton (Table II) during 1958 at the Colombo market. The prices were the highest between October to December, when a part of the imported potato is used as seed.

TABLE II

Retail and wholesale prices of potato in Colombo market during 1958*

Months	*Retail price per pound in cents*		*Wholesale price*	
	Co-operative price	*Market price*	*Per ton in Rupees*	*Per pound in cents*
January	28	29	483·40	22
February	27	28	400·00	18
March	27	28	466·60	21
April	29	31	460·00	21
May	29	29	530·00	24
June	28	31	520·00	23
July	29	32	540·00	24
August	31	32	560·00	25
September	31	32	550·00	25
October	29	33	560·00	25
November	31	33	572·60	26
December	29	29	560·00	25
Average during the year	29·0	30·6	516·88	23·3

* Report of the Department of Census and Statistics, Ceylon.

FOOD VALUE AND CONSUMPTION, PER CAPITA

THE potato is a rich source of calories. It is one of the crops which builds up food reserves at a very fast rate, and the returns are, therefore, very quick. Besides carbohydrates, the potato contains

appreciable quantities of high grade proteins, vitamins and minerals. It is, therefore, not only productive, but a protective food as well. The various ingredients found in the potato are :

Carbohydrates : Nearly one-fifth of the fresh weight of potatoes consists of carbohydrates, which is the main source of calories. It has been shown that the starch of the potato is of a high order, and about 95 per cent. of calories available in the potato is digested (Burton, 1948*).

Proteins: About two per cent. of the fresh weight of potato tuber consists of proteins. Nutritional experiments have shown that the quality of potato proteins is very high and 85 per cent of the total nitrogenous material present in the potato is absorbed by the human body.

Vitamins : Vitamin C and vitamins belonging to group B, present in the tuber in significant quantities, are the most important constituents of the potato. Being water-soluble, these vitamins are preserved in the tuber, if the cooking is quick and the skin remains intact.

Minerals : There are appreciable quantities of potassium, calcium, phosphorus and iron present in the tuber. Besides, the potato contains minute quantities of several other minerals.

Assuming the population of the Island to be 10 millions—the imports of 43,250 tons would allow 9.7 pounds per individual, per annum. This, when compared to 400 lb. per capita per annum in some European countries, is indeed very small. The necessity of greater production and greater utilization of potatoes, particularly in context of rice shortage in Ceylon, is obvious. It should be remembered that the potato is an acceptable article of diet with local people and can be served in a variety of ways. Its utilization in larger quantities in daily diet of the people is not likely to present difficulties.

The utilization of more potatoes in the daily diet of the people is possible only if a country has its own internal sources of production.

*Burton, G. W. (1948). Potato. Chapman Hall Ltd., London.

It is with this end in view that the prospects and programme of future potato development in the Island have been discussed in some detail in the following pages.

TECHNOLOGICAL POTENTIALITIES

IN my previous report* I had indicated that the climate in the hill regions of Ceylon is very suitable for potato culture. Over a large part of the year, several successive crops could be grown by adjusting the dates of sowing. I had also stressed, at several meeting, that the crops could be raised without irrigation. In several areas in the hills, rainfall distribution is such that the lack of irrigation facilities does not constitute a limitation in the successful exploitation of the potato.

The reports now available to me show that three crops a year have been successfully raised on a large field scale. The times of sowing and harvest of the three crops were :

First crop

Sowing—January
Harvest—April

This crop has no late blight. It can be raised in areas free from frost.

Second crop

Sowing—July
Harvest—October

This crop is affected by late blight only in situations which receive heavy north-east monsoon showers as at Bopatalawa. In areas where south-west monsoon is weak, the crop is usually free from late blight.

Third crop

Sowing—end of October
Harvest—end of January

This crop, like the second crop, may suffer from late blight in areas which receive heavy rainfall during north-east monsoon between October and December.

*Pushkarnath (1958). Tropical Agriculturist, Vol. CXIX, No. 2.

Besides the three crops mentioned above, successful crops have also been raised at the Departmental Farms when potatoes are planted in between the sowing times indicated above. Thus, a crop sown in April and harvested in June has been highly successful at Rahangala. This crop though free from late blight is, however, sometimes subject to damage due to heavy winds. The crop is, therefore, successful only in wind-protected regions.

I also observed the cultivators' holdings, where the potatoes were sown periodically, the crops were highly successful. To cite an example Mr. A. Maswelagedera, a School Master at Kuda Oya, Labukelle, planted three successive crops of potatoes on December 7, 1959, January 16, 1960 and February 1, 1960. The first crop sown in early December produced excellent yields and was remarkably free from diseases of all types.

The main conclusions which can be drawn from these new experiments and experiences are that in the hill regions conditions are favourable for successive cropping of potatoes throughout the year and fresh supplies of potatoes should, therefore, be available in required quantities, at all times during the year, for table use in the Island.

With the seed supplies that would now be available locally (see Section II) it would be necessary to plan the future extension programme of potato production in the Island on a scientific basis. In any geographical region success in potato culture depends on several factors of which the climate is the most important. Among the climatic factors that directly influence the size of the crop are (*a*) Temperature (*b*) Photo-period and light intensity and (*c*) Rainfall. How important these and other factors are in influencing tuberization (and consequently the size of the crop) can be appreciated by a more detailed consideration of the important factors.

Temperature : Speaking broadly, sizable crops can be expected if the mean temperature during the growing season does not normally exceed 70°F. Because of the Island's nearness to the equator, the climate of the country is naturally warm. In the higher elevations the temperature perceptibly drops (roughly one degree for every 300 feet rise in height). In the following table, monthly mean temperatures of a few places situated at varying elevations are provided :

TABLE III

Monthly mean temperatures at selected places *

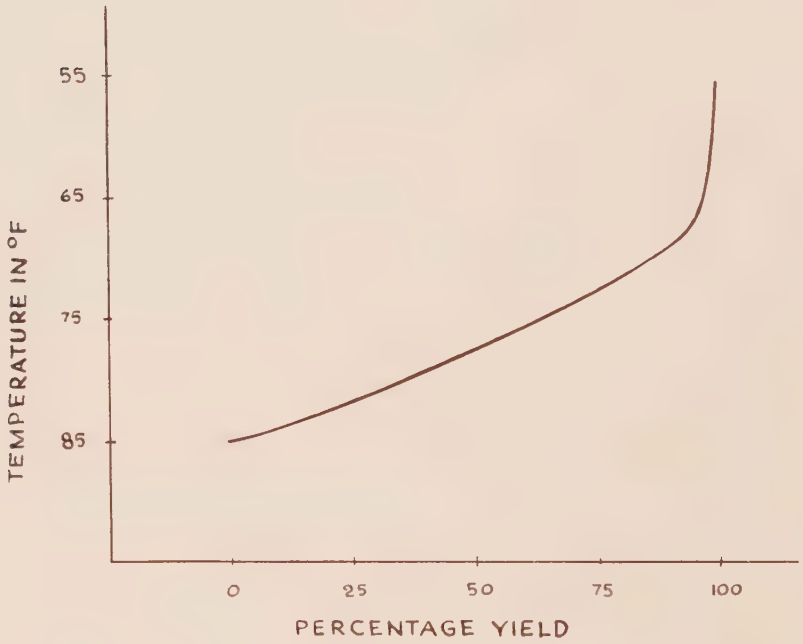
(Averages between 1911 to 1940)

Station	Height above sea level	No. of years (average)	Average temperature during the month in °F												Average
			January	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
	(feet)														
Trincomalee ..	11	28	77·9	79·2	81·1	83·4	85·5	85·7	85·5	84·7	84·6	81·6	78·2	78·0	82·2
Jaffna ..	14	29	77·6	79·1	82·3	84·9	84·9	84·8	82·3	82·4	82·8	81·7	79·5	77·8	78·9
Colombo ..	24	28	79·1	79·6	81·0	81·8	82·3	81·4	80·8	81·2	81·0	80·1	79·3	78·0	79·7
Galle ..	41	27	78·4	79·5	80·7	81·4	81·6	80·4	79·7	79·7	79·9	80·1	78·9	78·5	79·8
Anuradhapura ..	259	27	76·3	78·3	81·5	83·0	83·6	83·2	83·2	83·5	83·4	81·2	78·6	76·7	79·2
Kandy ..	1,572	28	73·6	74·9	77·5	78·9	78·3	76·4	75·5	76·0	76·3	76·7	75·2	73·9	76·0
Badulla ..	2,197	29	70·0	71·1	73·4	75·2	76·0	75·4	75·3	75·3	75·0	74·2	72·4	70·6	73·7
Diyatalawa ..	4,093	29	64·7	65·9	67·9	69·2	70·4	70·4	70·2	69·8	69·4	68·4	67·1	65·4	68·1
Nuwara Eliya ..	6,170	27	57·4	57·5	58·7	60·6	61·9	60·7	60·1	60·3	60·1	59·9	59·5	58·4	59·7

* Figures compiled from the Report of the Colombo Observatory, Govt. Press, Ceylon.

Observations carried out at the Central Potato Research Institute, Simla (India), have shown that the highest yield can be expected when the mean temperatures during the growing season are below 68°F. Mean temperatures of 70°F. may, however, be generally regarded satisfactory for economic crops. Under Ceylon conditions crops mature in about three months and to ensure good tuberization require low temperatures during this period. With the rise in temperature during the growing season, the expected depression in tuberization would, in general, follow the curve indicated in Fig. 1.

Figure I

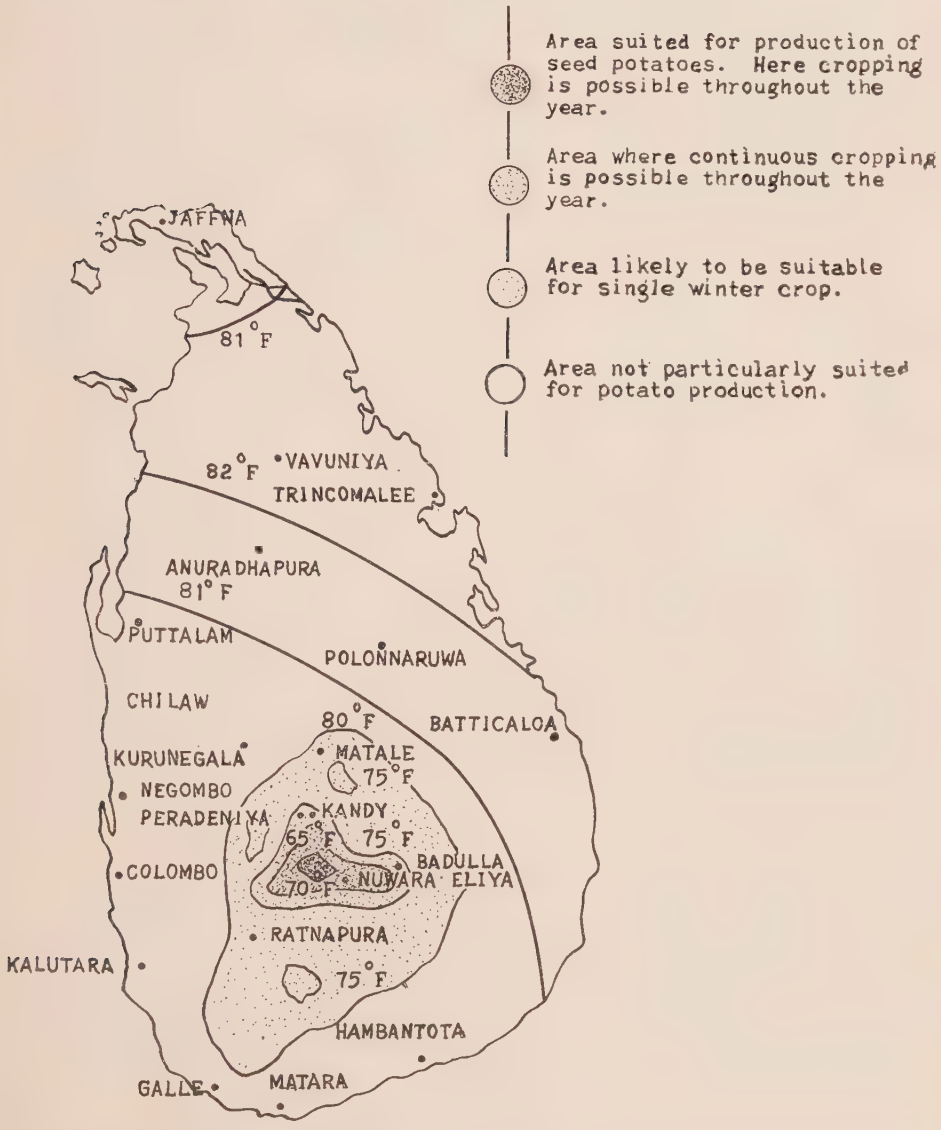


The conclusions that could be drawn from the above are:

1. The areas including in Isotherm of 70°F (shown in the map in Fig. 2) should be considered suitable for raising the potato crop over a larger part of the year. This area lies roughly about 5,500 feet above the sea elevation. The small high hill area, lying within the isotherm of 65°F, being particularly suitable for seed potato production.
2. The conditions for potato growing would appear to be not particularly suitable for potato cultivation in isotherm beyond 70°F. However, in the region between 70°F, and 75°F, possibly

Figure II

MAP SHOWING AREAS SUITED FOR POTATO CULTIVATION



upto isotherm demarcated by 80°F, it should be possible (if other conditions like bacterial wilt, etc., do not prove a handicap) to raise at least one average crop of potato between December and February.

3. The plains of the country, where the mean temperature ranges between 80° to 82°F, are not climatically well suited for potato culture. I have examined the daily variations in the temperature during November, December, January and February at five places in this region. The available data (average of three years 1948 to 1950) are provided in Table IV below :

TABLE IV

Mean maximum and minimum temperatures between November and February at five selected places in the plains of Ceylon. (Average 1949-1950)

Places	*Temperature in °F*							
	November		*December*		*January*		*February*	
	Max.	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*
Trincomalee	90·8	71·6	83·7	71·1	83·3	69·9	85·9	70·4
Jaffna	88·7	70·3	79·6	68·5	84·7	67·5	88·4	67·5
Colombo	88·3	70·7	89·3	68·1	91·3	65·1	93·4	65·7
Galle	86·9	71·6	86·0	70·4	87·3	69·9	88·5	70·6
Anuradhapura	92·1	65·8	87·6	62·9	87·3	65·3	82·0	62·3

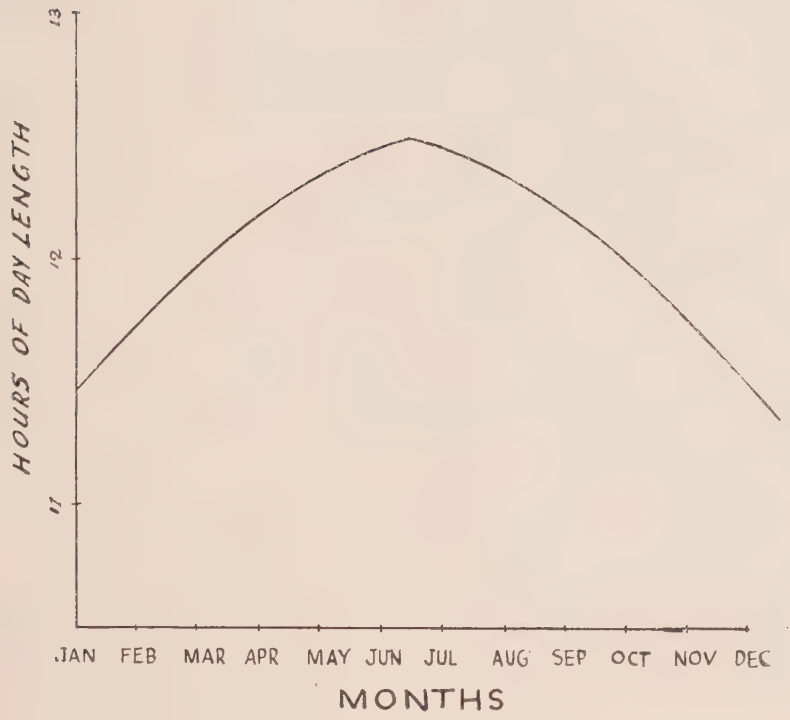
The range in temperatures would indicate that the temperatures fall below 70°F. Under such conditions, some tuberization should be possible but good crops cannot be expected. Moreover, the commercial quality of the produce under such conditions is likely to be very low. Growth deformities (which may be exhibited as irregularities in the shape of tuber, knobbing or growth cracks, &c.) are expected to be a characteristic feature of the produce secured under conditions of stress. Some varieties are more adapted to high temperatures and selective processes may lead to selection of varieties likely to yield economic returns even in the plains.

Photoperiod : Long photoperiods (more than 12 hours) are generally conducive to vegetative growth and flowering. Long photoperiods, if accompanied by high temperature, would induce rank vegetative growth at the expense of tuberization. Lower temperatures counteract, to a large measure, the influence of long-day environment and good tuberization may be expected even under somewhat long-day conditions if the temperatures are otherwise favourable.

Data on photoperiodic conditions in the Island have been kindly given to me by Dr. Chandraratna and are reproduced in Fig. 3.

The reference to the curve in Fig. 3 will show that photoperiodic conditions in Ceylon are by no means unduly long so as to prevent tuberization. Conditions between October and December and January

Figure III



and March are somewhat favourable for tuberization. Good tuberization can be expected even during April-September as the temperatures are low.

Yet another factor to which I would like to make a reference, in this connection, is that most of the varieties grown in Ceylon are bred to suit long-day environment prevalent in the European and Scandinavian countries. A photoperiod of 11½ to 12½ hour in the hill regions of Ceylon is by no means a factor which should be considered as a serious limitation in the way of successful cultivation of potatoes. Good crops of potatoes can be raised under hill conditions of Ceylon almost throughout the year and greater success can be assured by selection of varieties made to suit the local range of photoperiods, which is very limited.

Rainfall: Rainfall is a consideration for areas where irrigation of the crop is not possible. Rainfall data for three different hill elevations (where potato culture is possible in one season or the other) are provided in Table V.

TABLE V

Mean Average rainfall in hill regions of Ceylon

(Average of about 30 years 1911-1940)

Place	*Height above sea level*	*Average rainfall during the month in inches*												*Average Annual*
		Jan.	*Feb.*	*March*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	
	(feet)													
Kandy ..	.. 1,572 ..	6·73	2·36	5·46	5·96	6·47	7·30	5·89	4·75	5·97	11·57	10·67	8·86	82·19
Diyatalawa ..	.. 4,093 ..	6·62	2·33	4·87	6·56	6·05	2·01	1·93	3·15	4·49	9·16	10·40	8·11	65·58
Nuwara Eliya ..	.. 6,170	7·00	2·01	4·10	4·95	8·45	10·43	11·03	7·48	8·24	9·78	9·16	7·86	90·49

A rainfall of about four inches per month, on an average about an inch per week, is more than adequate for success of the crop. Such conditions exist for a larger part of the year in the hill areas above 5,000 feet. Recent experiments carried out at Rahangala, between October, 1958, and January, 1959, show that successful crops can be raised under rainfed conditions. The absence of rainfall even for a week or two, it was observed at Rahangala, does not seriously affect the crop. Through proper adjustments of growing seasons (taking into consideration the rainfall distribution) it should be possible to raise good crops of potatoes without irrigation in the hill areas. Low temperatures prevailing in the hill regions would help the crop to bridge over short rainless periods. Results of periodic sowing of the crop (say fortnightly) would yield rewarding information, if the experiment is carried out in a manner that the yield data of successive plantings can be taken into consideration at the time of analysing results. Such experiments should be conducted both in south-west and north-east monsoon belts.

Soil : The potato can be grown almost on any type of soil, provided it is not saline or very heavy clay. Great variability in soil types met within the hill areas is, therefore, not of much consequence with respect to potato culture. Two features which render the hill soils of Ceylon particularly suited for potato culture are that :

(*a*) soils are well drained, and

(*b*) they are acidic in reaction.

A soil reaction of about pH 5.0 is preferred. Crops can, however, be successfully grown on soils with a lower pH. On the other hand, pH value of about 5.5 is not expected to improve the crop or the marketable quality of the produce. The hill soils of Ceylon have a pH value of about 3.8 and 5.5 and admirably support potato growth even though slight improvement in pH value through use of 5 to 10 cwt. of Dolomite lime is reported to further improve yields (Ponnamperuma, 1958*).

CONCLUSIONS

The crop growth conditions in the hill regions of tropical Ceylon are by no means such as are likely to create difficulties in successful cultivation of potatoes. In fact, the temperature, rainfall and soil conditions are very suitable for the crop which can be grown throughout the year. Irrigation which was considered to be necessary for

* Ponnamperuma, F.N. (1958). Response of Potato to Fertilizers, Manures, Lime and Trace Elements. Tropical Agriculturist. Vol. CXIV, No. 2.

cultivation of the crop is not a factor of much significance under the conditions prevailing in the hill regions of Ceylon. Crops can be grown without irrigation and occasionally light irrigation may be needed only in seasons or years of extreme drought.

The plant growth under tropical conditions is rapid and the crops mature within a short period of about twelve weeks. Theoretically, it should be possible to raise in the same land during the year four crops, but giving allowance for cultivational adjustments, &c., production of two to three crops in a year is within easy practical limits.

Few countries in the world enjoy such advantages, as are bestowed by nature on the Island of Ceylon, for successive cropping of potatoes in the hill areas. Exploitation of full resources from the land remains only to be a human problem.

SECTION II

PROBLEMS OF POTATO CULTURE IN CEYLON

A.—PROBLEMS RELATING TO SEED POTATO PRODUCTION

Need for good seed potatoes

Necessity for production of seed locally

Seed potato production pilot project

Future working of seed potato production project

Seed potato production targets

Use of sprouted and cut seed

Concluding suggestions

B.—PROBLEMS OF RESEARCH

Varietal problems

Disease and disease control

Fertilization and manuring

Cultural problems

Concluding remarks

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PROBLEMS OF POTATO CULTURE IN CEYLON

POTATO culture is a new venture in Ceylon. Naturally, therefore, it is necessary to secure the needed information for the successful cultivation of the crop and maximisation of yields. I, therefore, propose to deal with few problems so as to focus attention to the important and fruitful phases of research.

A.—PROBLEMS RELATING TO SEED POTATO PRODUCTION

Need for good seed potatoes: Success of the project would depend on the quality of seed used. Good seed potato is one which has the inherent capacity to produce high yields under environments in which it is grown. A good seed must be:

(*a*) **True to type:** Yield is an inherent quality of the variety and no cultural treatments can, therefore, overcome the defects of a wrong choice of the variety. At all stages of multiplication of seed, the varieties selected must be maintained in a pure state, free from mixtures and other undesirable variations which often arise spontaneously in field.

(*b*) **Healthy:** Quality of seed is seriously affected by several virus diseases which are the cause of degeneration of seed stocks. Use of degenerated seed results in a serious and a permanent reduction in yield. Degenerated seed potatoes also do not show the expected response to good manurial treatments. Availability of healthy seed stock, in time for planting, is, therefore, one of the major factors in successful crop cultivation.

(*c*) **In proper stage of sprouting:** It is well known that the potato tuber does not sprout, i.e., germinate, immediately after harvest. A "rest period" is needed before the tuber sprouts. Unsprouted or ill-sprouted tubers take a long time to germinate and seed pieces sometimes rot in the field even before germination. Well-sprouted seed ensures good germination and a uniform stand of the crop.

Necessity for production of seed locally: Hitherto, Ceylon has been importing all its seed requirements (limited though they were) from outside. This was so because the tropical conditions have been considered not particularly favourable for seed potato production. The production of seed potatoes was not, therefore, considered feasible within the Island in the past. During my previous visit in 1958, I came

to the conclusion that commercialisation of the potato in Ceylon could be possible (on the scale visualised) only if seed potatoes could be raised locally. The following were the main considerations which led me to this conclusion :

(1) Ceylon, it appeared to me, could raise successive crops of potatoes during the year. Timely imports of quality potatoes for all the plantings in the Island would be difficult and delays in shipment or transport from the port of entry to the distribution centres would often create serious difficulties.

(2) Several exporting countries* had no effective seed production and certification organizations. The quality of imported seed potatoes could not, therefore, be expected to be always of a high order. Countries where good seed certification organizations did exist, could supply seed potatoes (in a condition immediately fit for planting) only during certain season of the year.

Moreover, several cultivators have been planting and are still planting over-sprouted table potatoes as seed and this could hardly be avoided without establishing assured sources of seed supply.

Imported table potatoes used as seed (the crate was photographed in a field at Nuwara Eliya)

*Potatoes are imported into Ceylon from Kenya, British possessions in Africa, India, Republic of China, Egypt, France, Iran, Italy, Japan and Netherlands. No distinction is made between seed potatoes and table stocks.

(3) There are several diseases which, if imported with seed (or table potatoes used as seed), would cause permanent damage, at one time or the other, to the potato industry in the Island. Some such diseases are :

(*a*) **Bacterial wilt :** The bacteria causing the disease (*Pseudomonas solanacearum*)* which is known to be prevalent in several Mediterranean countries could sometimes be carried to areas where there exists, at present, no bacterial wilt.

(*b*) **Wart :** Wart, caused by *Synchytrium endobioticum* is a severe disease, which at one time threatened the extinction of the potato industry in Britain. It is also present in several European and Scandinavian countries. It affects the tuber and causes development of severe wart like lumps, of varying sizes and shapes, all over the surface, and the entire tuber is often rendered unfit for table use. The disease is easily communicated through seed tubers. Even sound-looking seed tubers may be infected. Only a very close inspection, through a magnifying lens, would reveal the tiny pinhead warts.

Conditions in the hill areas of Ceylon appear to be favourable for the development of this disease. It thrives in a wet climate at a temperature range of about 50° to 86°F. It is also known that the fungus survives in somewhat acidic soils, and even in highly acid soils upto a pH level about 3.9. The resting spores may remain viable in the soil, even without a potato crop, for several years ; sometimes over 12 years. Thus, once the soil is contaminated and infection builds up, the soil is rendered, more or less permanently, unfit for potato production.

* Dr. J. W. L. Peiris, Plant Pathologist, informed me about the identity of the organism. It should also be checked up if *Corynebacterium sepedonicum* is prevalent on potatoes, in the Island.

(c) **Golden Nematodes**: Like the wart, the Golden Nematode (*Heterodera rostochiensis*) limits potato cultivation once the soil is infected. The larvae and eggs remain viable for several years in the body of the dead female which develops a very thick warty cuticle on the surface. These cysts can easily be carried on the surface of the tuber particularly on eyes, growth cracks, &c. There are no satisfactory and practical measures yet known to control the disease.

Seed potato production pilot project: In 1958, the work on potato was concentrated at Rahangala farm. Besides several experiments carried out at the farm by the specialist officer, production of seed potatoes was also attempted. It was unfortunate that the situation was not particularly suited for the type of work carried out. Thus, the aphid infestation on the crop, at least in some seasons, was usually high (as was observed by me in March, 1958). It was not surprising, therefore, to find high incidence of virus diseases on the crop at this situation. The soils were also not free from Bacterial wilt. Judging from the crop conditions at Rahangala, indeed, at one stage, it appeared to me that perhaps not much could be done in developing a seed potato organization in the Island. It was later, only after I visited the higher elevations in the Horton Plains (7,200 ft. above sea level), towards the end of March 1958, that I visualised distinct possibilities for production of seed potatoes within the country.

From the technical point of view, situations like Horton Plains are very well suited for maintenance of the health standards of varieties. Here, at these elevations, extensive *patana* lands are available ; the temperatures are low ; the situations are exposed to winds and the rainfall is well spread out throughout the year. I, therefore, strongly advised the Government of Ceylon to initiate a pilot project on seed potato development at Horton Plains. This recommendation, I am happy to say, was vigorously pursued by the Department of Agriculture.

The Department of Agriculture secured in February, 1959, foundation stocks of Gineke, Tedria and Ultimus from the Netherlands. Besides, disease-free stocks of Up-to-date were also secured from the United Kingdom. Simultaneously, seed farms were also established

in the high hill regions*. The following statement gives the yield obtained with the original seed sown in February and the locally produced seed sown in July, 1959.

TABLE I

Yield of Gineke and Tedria with the seed imported from Holland and once grown locally at the Seed Farms in the hills†

Name of Farm	*Ht. above sea level (feet)*	*Original imported seed (January to April crop)*		*Once grown local seed (July to November crop)*	
		Seed rate (in lb. per acre)	*Yield per acre in cwt.*	*Seed rate in lb. per acre*	*Yield per acre in cwt.*
		(a) Variety : Gineke			
Oliphant (Uda Radella)	7,200	800	43·2‡	1,042	33·5‡
Sita Eliya (Moon Plains)	6,200	1,537	92·9	1·006	55·6‡
Ragala	6,000	3,024	163·0	1,019	116·8
		(b) Variety : Tedria			
Oliphant	7,200	2,368	55·0‡	1,288	66·5‡
Kandapola	6,000	3,449	106·8	1,544	149·3
Elk Plains	6,000	940	9·8‡	1,164	49·9‡

† The yield figures shown in this table were kindly made available by Mr. R. Wijesooriya, Farm Manager, Nuwara Eliya.

‡ Spraying operations could not be carried out with vigour in these crops. with the result that these crops were severely affected with late blight and that accounts for the low yield figures.

The figures of yields recorded above are based on the average yields obtained over a large acreage of crop varying from 5 to 30 acres. It will also be observed that in the first crop planted in February, the seed rate was very variable and in most cases very high. Further, in the first crop whole tubers were planted. In the second crop, however, the seed rate was much lower but more reasonable. This crop was raised using cut seed potatoes as seed.

The data on yield figures in Table I, therefore, are not strictly comparable, but would help to illustrate the position. In spite of the limitations imposed, lower seed rate and use of cut seed potatoes, the yields obtained from once grown seed compare very favourably with those secured from the original imported seed stock.

* Land at Horton Plains could not be made available to the Department of Agriculture but two other farms at similar elevations (about 7,200 ft. above sea level) were established at Oliphant Plains and Pidurutalagala.

At the seed farms twice locally grown (sometimes thrice locally grown as at Bopatalawa) seed had been planted. I examined these crops in the field. The crops were admirably healthy, and the percentage of virus infection (leaf-roll and occasionally severe mosaic caused by virus Y) was very low, less than one plant in a thousand.

A good crop raised from the State Farm Seed

Some observations on the incidence of aphid population per 100 leaves were recorded at Rahangala (4,300 ft. above sea level) and the higher elevations (6,200 ft.) at Sita Eliya (Moon Plains). It was reported* that the aphid counts in the higher elevations were extremely low, less than 1.5 aphids per 100 leaves, even during the peak season in March-April. At the lower elevations, however, as at Rahangala, the corresponding counts per hundred leaves during the same season peak periods were high, about 8.8 aphids per 100 leaves. Another interesting observation made at Rahangala was the complete absence of aphids in the July-sown crops which are exposed to high winds and heavy rainfall.

From the limited data available, it is obvious that :

(1) The higher hill elevations are very suitable for seed potato production ;

* By Dr. D. V. W. Abeygoonewardena, Research Co-ordinator, Rahangala.

(2) Certain seasons are very suitable for seed potato production as during these seasons aphids are completely absent;

(3) With an efficient seed inspection system it should be possible to maintain the health standards of varieties over long periods in the higher hill areas.

Future working of seed production project: The Department of Agriculture has already established eight farms (excluding Rahangala) for seed potato development work. Two of these eight farms, Oliphant (Uda Radella) and Pidurutalagala are situated at a higher elevation of 7,200 ft. above sea level. The other six Farms, viz., Galpalama, Ragala, Elk Plains (Meepilimana), Kandapola, Sita Eliya (Moon Plains) and Bopatalawa are situated at lower elevations, varying from 5,500 ft. to 6,200 ft., above sea level. It is the intention of the Department of Agriculture to feed the total crop area under cultivation (for which a target of 8,000 acres has been visualised) with the seed produced at the newly established seed farms. I examined the working of seed potato project and visited a number of seed farms. It is suggested that the work of seed potato development may be carried out under the following three stages:

Stage I: Maintenance and production of nucleus foundation stocks

The work of this stage, by necessity, has to be carried out under glass house conditions. The disease-free nucleus stocks of varieties needed for seed multiplication work can be initially procured by contact with the specialist in the field. The disease-free nucleus seed thus secured should be maintained and multiplied on a small scale (as space permits) under glass house conditions.

Stage II: Multiplication at foundation seed farms

The nucleus foundation produced (as under I above) should be rapidly multiplied at Pidurutalagala and Oliphant (Uda Radella) hereafter designated as "Foundation Seed Farms".

Stage III: Multiplication at certified seed farms

The remaining six farms at Galpalama, Kandapola, Sita Eliya (Moon Plains), Ragala, Elk Plains (Meepilimana) and Bopatalawa should serve as Certified Seed Multiplication Farms. These six farms, receiving seeds in required quantities for distribution to the cultivators.

The working of organization indicated above will be as follows :

Stage I	..	Disease free nucleus seed (Glass house)
		↓
Stage II	..	Foundation seed (High hills)
		↓
Stage III	..	Certified seed (Seed Farms)
		↓
		Seed distributing agencies

It has been suggested that an elaborate system of testing the seed at all stages of multiplication should be developed. I am not at this stage in favour of establishing a comprehensive seed testing organization. The necessity of such work can be determined later when some progress has been made in the development and extension fields at the field level. Moreover, before setting up a comprehensive seed testing organization, the percentage of virus infection in the seed crops during the successive stages of multiplication has to be determined to justify stricter control. I would, therefore, suggest that :

(1) For the present, the testing work be confined only to nucleus foundation stocks which should be *ensured* to be free from virus infection ;

(2) Rigid field inspections be carried out at the foundation seed farms and the crops examined and rogued (for any chance virus infected plants or off-types) two or even three times during the growing season ;

(3) At the certification farm, routine examination of the crop for health standards and varietal purity be maintained. One or two field inspections during the crop season should be adequate ;

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(4) Full data about the seasonal development of aphids on the potato crop at the seed farms be secured. A routine fortnightly count of aphids per hundred leaves should be adequate to make further adjustments later on, if necessary, in the seed potato development programme ;

(5) Potato seed farms be used exclusively for seed potato development work and temptations to carry out experiments with other crops be strongly restricted.

Seed potato production targets : Under the project production of 40,000 tons per year is aimed at. On the assumption that average yield per acre would be four tons and that three crops in a year are raised, the targets can be achieved if 3,333 acres of land are devoted to potato crop in each season. It may not, however, be convenient or possible under cultivators conditions to raise three crops in a year in all the situations. Giving allowance for such contingencies, it may be assumed that about 4,000 acres under the potato crop, during the season, would yield production targets of 40,000 tons per year as laid down. At the seed rate of 0.75 ton* per acre, the total of 3,000 tons of seed per crop season would be required to feed 4,000 acres.

About 750 crop acres would be needed to produce the needed seed of 3,000 tons in each season. Total area required for seed multiplication farms would be 1,000 acres, allowing for 1/3 area as fallow or in rotational crop during the season. It has also to be taken into consideration that all the produce may not be useful for seed purposes and on a liberal estimate 1,200 acres would be needed to meet the seed requirements at the level envisaged.

From the statement provided in Table II it would be seen that in the six seed certification and foundation farms established, total acreage is only 555 acres which from the calculations indicated above will have to be substantially increased if the entire area is to be fed with the seed produced at the Seed Farms.

In this connection, it may also be pointed out that additional seed requirements could also be secured through the co-operation of a few selected progressive growers from areas considered suitable for seed potato production.

* This would allow some shrinkage, losses during the short storage period of two to three maund. The actual seed rate would be somewhat less ; about 0·5 to 0·6 tons per acre, depending on the seed size and spacing adopted.

TABLE II

Statement showing the area and expected yield of seed potatoes at foundation and certification seed farms

(In acres)

Stage	*Name Details*	*Name of Farm*	*Total cultivated area*	*Total area under crop per season* [1]	*Yield in tons at 4 tons per acre per season* [2]	*Total seed available per year on farms* [3] *(Tons)*
Stage I ..	Foundation Seed Farms	Oliphant ..	51 ..	34 ..	136 ..	408
		Pidurutalagala ..	100 ..	75 ..	300 ..	900
	Total under Foundation Seed Farms	do. ..	151 ..	109 ..	436 ..	1,308
Stage II ..	Seed Certification Farms	Sita Eliya (Moon Plains) ..	210 ..	140 ..	560 ..	1,680
		Galpalama ..	51 ..	34 ..	136 ..	408
		Elk Plains (Meepilimana)	90 ..	60 ..	240 ..	720
		Ragala ..	90 ..	60 ..	240 ..	720
		Kandapola ..	24 ..	16 ..	64 ..	192
		Bopatalawa ..	120 ..	80 ..	320 ..	960
Total for Stage II		..	555 ..	390 ..	1,560 ..	4,680
Grand total Stages I & II		..	606 ..	499 ..	1,976 ..	5,920

(1) It is assumed that $\frac{2}{3}$ area will be under crop per season. (2) Average yields assured at 4 tons per acre. (3) Total for three crops.

In connection with the working of the seed farms, I would like to make the following further suggestions :

(1) The work on the development of foundation seed stock (Stage II) should be concentrated first at Pidurutalagala farm and later extended to Oliphant Plains, if extension in area of seed certification farms is decided upon.

(2) To maintain the targets of yield at least at four tons per acre per crop, particular attention should be paid to efficient crop and soil management at the seed farms. The tendency towards fall in yields should be arrested from the very beginning.

Terracing, drainage, planting along contours, crop rotation* and a liberal application of compost and other forms of humus besides the fertilizers are some important aspects of crop planning and management. Specific measures that could be adopted under different situations were discussed during my field tours and at the meeting of Farm Managers and Extension workers held at Nuwara Eliya on 26.2.60.

(3) Potatoes should be grown only in such areas which are suited for seed potato production. The use of water-logged or otherwise poorly drained land should be avoided. The importance of this is amply illustrated by the figures in Table III where the yields obtained at Bopatalawa Seed Farm from the low lying water-logged areas are recorded to be less than 50 per cent. of those obtained from well drained highlands.

TABLE III

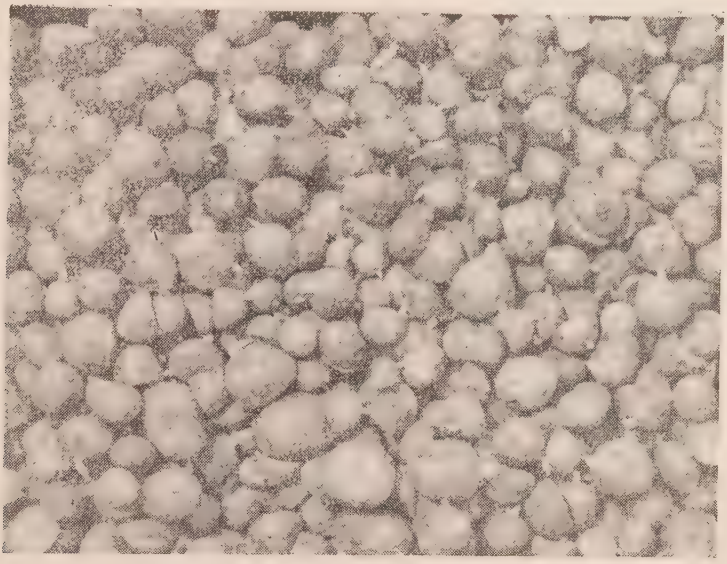
Yields obtained in highlands and low water-logged lands during 1959 (May-June harvest) at Bopatalawa

Highlands			*Lowlands*		
Total area in acres	*Average yield per acre*		*Total area in acres*	*Average yield per acre*	
	Tons	*cwt.*		*Tons*	*Cwt.*
52·6	3	0	25·7	1	7

Use of sprouted and cut seed : The growing season in Ceylon being very short, it is essential that the seed should germinate very quickly and uniformly. Use of well-sprouted seed will thus ensure a good

* Only legumes should be introduced in rotation for green manuring purposes.

crop. Use of well-sprouted seed will also avoid the possibility of decay which usually occurs during heavy rainfall or drought conditions following planting. Partially-sprouted seed or seed pieces forced to sprout (through the use of Thiourea) as has been done at Moon Plains is likely to procrastinate germination. Late or irregular germination often causes grave concern to the cultivators. This should be avoided, particularly in the initial stages of development work.



Freshly harvested tubers cut and forced to sprout through the use of Thiourea

With three crop system a year adopted at the seed farms there should be no difficulty to maintain a regular supply of well-sprouted seed to the cultivators.

Grading of seed potatoes before issue to cultivators is necessary. There appears to be no objection to adopt the practice of use of cut-seed potatoes. Use of cut-seed pieces should be avoided if the cultivators are not acquainted with potato culture. Practice of using cut-seed potatoes could be adopted with advantage at the farms. Closer planting at farms should yield more seed sized tubers.

Concluding suggestions: Keeping in view the targets already laid by the Department of Agriculture and the increased activity that is to follow the achievements already made, it is estimated that the targets of seed potato production will be fulfilled by the end of 1961. At the same time fresh table potatoes, in adequate quantities, should

be available in the Island throughout the year. To facilitate continued success of seed potato development programme and also to ensure a rapid and a planned extension of potato culture in the country, it is of utmost importance that urgent action should be taken to :

(1) Stop all imports of seed potatoes by 1961 ;

(2) Gradually restrict (beginning with the middle of 1960), the imports of table potatoes with a view to stop their imports completely in 1962.

B.—PROBLEMS OF RESEARCH

IN several fields an organised programme of research is necessary to stabilize potato culture in the Island and to improve the yield and quality of the produce. I shall in the following paragraph touch upon only important and immediate problems.

Varietal problems: Varieties to be recommended must be, besides adapted to local conditions, commercially acceptable and resistant to the diseases. The varieties Gineke, Tedria and Ultimus selected for the pilot potato development project are not particularly attractive. The main reason why they were selected, in preference to other high yielding types like Alpha, Great Scot, &c., was their field resistance to late blight. Of the varieties Tedria and Ultimus occupy only a secondary position in the seed development plan as their full potentialities are yet being investigated. Up-to-date which is the fourth variety included in the seed development plans is susceptible to late blight and although it has given the highest yields (14.1 tons per acre) in the trials carried out at Rahangala during 1957)* and possesses a wide adaptability† it has not yet been released for distribution.

Gineke, the chief variety which is distributed to the cultivators under the seed multiplication plans of the department, is not particularly attractive. It has somewhat irregularly shaped tubers with somewhat deep eyes. The tubers, though attractively coloured light red, acquire an unhealthy look after a short period or storage. With a view to select suitable varieties for culture it is necessary that an effective varietal testing and selection programme should be initiated. As remarked earlier, Rahangala is not suited for such investigations and the centre of activity for varietal investigations should be shifted from Rahangala to Sita Eliya, a site which is conveniently situated near Nuwara Eliya.

* Ariyanayagam, D. V.—Variety and Culture trials with potato. T.A. Vol. CXIX.

† Has been found to do better than other varieties at Peradeniya and Jaffna in trials examined by me.

In selection work the following main objectives should be kept in view :

(*a*) **Wide adaptability :** Varieties selected have to grow at varying height and in different seasons. A wide degree of adaptability is, therefore, necessary. To achieve this objective it is suggested that after preliminary selection at the Sita Eliya Station a small group of selected varieties be tested at Jaffna where a substation should be located. During my recent visit to Jaffna it appeared to me that although there were little immediate prospects for potato culture, the possibility of potato growing in this area could not be altogether eliminated. Selection of varieties which would favourably respond, as regards tuberization, to higher temperatures should yield results of value.

(*b*) **High yield :** Less than four tons to an acre under average conditions of culture, should be regarded as uneconomic yields. The level of yields can be considerably increased through proper selection of high yielding varieties.

(*c*) **Good shape, size and colour :** Round to oval tubers of good uniform shape generally find favour in the market and with the housewife. White, smooth-skinned tubers should be preferred. Presence of shallow eyes is necessary.

(*d*) **Moderately short dormancy period :** This is a desirable attribute as varieties with longer dormancy or short dormancy periods are likely to create difficulty in making available, for several plantings, seed tubers in the right stage of sprouting.

(*e*) **Good keeping quality :** Thick firm skin and good keeping quality would help in handling and marketing of the produce and avoid losses in storage.

(*f*) **Some resistance to degeneration diseases :** Some resistance to degeneration diseases, particularly Leaf-Roll and Virus Y, are factors of considerable importance in maintaining health standards of varieties over a longer duration.

(*g*) **Cooking quality and nutritive value :** These objectives, for the present, need not be pursued. As the work develops quality aspect of the varieties should be taken into consideration.

Besides the above objectives, resistance to late blight (dealt with separately in the following paragraph) is very necessary.

Disease and disease control: The two diseases, namely Late Blight and Bacterial Wilt, are of importance in Ceylon. Information available indicates that late blight is particularly severe in the hills. Higher, cooler locations are more favourable for development of the disease. Apart from the temperature, the rainfall and humidity are equally important factors. Late blight is severe during the cloudy season when the humidity is high. The average number of rainy days (average 1911-1940) at Diyatalawa and Nuwara Eliya (which represent two different rain fall zones—the former receiving the North-East Monsoon and the latter the South-West Monsoon) is shown in the table below. The table will reveal that in Diyatalawa region the greatest danger of late blight lies in the period between October and January while in Nuwara Eliya the period of late blight infection would appear in severe epidemic conditions between June to November.

TABLE IV

Mean number of rainy days at Diyatalawa and Nuwara Eliya during various months

(Average of 30 years, 1911 to 1940)

Months	*Places*	
	Diyatalawa	*Nuwara Eliya*
January	16	14
February	8	7
March	13	11
April	17	15
May	14	18
June	8	25
July	7	24
August	9	22
September	11	20
October	20	22
November	22	22
December	20	17

Control of late blight is possible:

(*a*) By introducing into cultivation practice of regular and timely schedule of spraying.

(*b*) By adjusting sowing times so as to avoid periods of late blight incidence.

(*c*) By selection and introduction of late blight resistant varieties.

(i) **Fungicidal control of late blight:** Several fungicides are known to be useful against late blight. Experiments carried out at Bopatalawa (Abeygoonewardena and Peiris, 1958*) have shown that under Bopatalawa and Rahangala conditions Dithiocarbomates are superior to the

* D. V. W. Abeygoonewardena and J. W. L. Peiris (1958). Tropical Agriculturist—Vol. CXIV.

copper fungicides. While the trials with different types of fungicides may be continued to test their efficiency, it would be very desirable to carry out extended fungicidal trials with a view to develop and draw out spraying schedules for different crop seasons and varying climatic conditions in the potato growing areas of the island. I must emphasise that correct and timely spraying is very important in adopting fungicidal control measures against the disease.

(ii) **By adjusting sowing times so as to avoid periods of late blight incidence :** Cost of spraying is usually high and adoption of spraying as a general cultural practice is involved with organisational difficulties. Some relief against late blight can be possible if the time of sowing is carefully adjusted so that the crops are sown by the cultivator, if possible, only during periods when late blight does not usually appear and if it appears its intensity is low. How far it would be necessary to grow commercial crops under conditions which are favourable to heavy late blight infection should also be carefully examined for it might be desirable to grow only two crops in place of three and completely avoid " late blight period " in the cropping pattern. Such adjustments should make it possible to introduce into culture high yielding and widely adapted varieties like Up-to-date, which are susceptible to late blight.

In several countries considerable advances have been made in breeding for late blight resistant varieties. A good range of material, which shows, considerable degree of field resistance is now available. It should be possible to secure such varieties and test them under local field conditions.

Later, as work develops, it may be desirable to undertake breeding work on field immunity to physiological races of *Phytophthora infestans,* the fungus causing late blight disease.

Bacterial wilt : It has now been established that bacterial wilt is caused by *Pseudomonas solanacearum**. The disease is both soil and seed borne. It is necessary that some system of internal quarantine should be adopted so that the disease does not spread all over the Island. Once the disease is transported to new soils it is likely to build up fairly quickly as the climatic conditions prevalent in the hill regions are very favourable for the development of the disease. Bacterial wilt organism has also a wide range of other host plants and can survive in the soil.

In my previous report I had suggested that a quick survey should be carried out to locate areas which are free from the wilt organism.

* Information supplied by Dr. J. W. L. Peiris, Plant Pathologist.

It was indicated that higher hill elevations may yet be free from infection. The examination of the data of a series of trials carried out by Dr. Abeygoonewardena, the Research Co-ordinator,* over a wide area covering the elevations from 3,000 to about 5,500 ft. has yielded some results of value. The main conclusions that can be drawn are :

(1) At heights above 5,500 feet very little, if at all any, infection is present in the soils. This would be obvious from the data provided in table below :

TABLE V

Percentage of Bacterial wilt infection at different elevations

Height Range (in feet)	*Average percentage wilt*	*Range of wilt infection (percentage)*
3,000 to 4,000	36·6 ..	18·8 to 53·3
4,000 to 5,000	47·8 ..	26·8 to 57·90
5,000 to 5,500	36·78 ..	29·56 to 44·0
Above 5,500 (Nuwara Eliya District) ..	0·02 ..	0·0 to 0·03

(2) A point which required verification was that cattle manure invariably carried infection.

On this point the Research Co-ordinator, Rahangala, in his Administration Report for 1959 has produced data which are summarised in the following table :

TABLE VI

Percentage of Bacterial wilt infection in cattle manured and unmanured plots

Height Range (in feet)	*Percentage infection*	
	With cattle manure	*Without cattle manure*
3,000 to 4,000	46·76 ..	42·76
4,000 to 5,000	47·00 ..	52·65
5,000 to 5,500	44·00 ..	29·56
Above 5,500 (Nuwara Eliya District) ..	0·00 ..	0·03
Average ..	34·44	31·25

There appears to be no basis for the belief that the cattle manure is the chief agent for spread of the bacterial organism. If infected soil is removed along with the cattle manure, there is no doubt infection

* Administration report of the Research Co-ordinator, Rahangala, for 1959.

may be carried along with the soil from one region to the other. If adequate precautions are taken not to transport cattle manure from bacterial wilt-infected regions, there should be no objection to use of cattle manure for the potato crop.

The Research Co-ordinator, Rahangala, in his report referred to above has shown that paddy lands have generally less percentage of bacterial wilt than the lands which do not have paddy as the main crop. These observations are of interest for if and when it is desired to extend the potato cultivations to elevations lower than about 5,000 ft. potato could be cultivated in rotation with paddy.

TABLE VII

Percentage of bacterial wilt infection in paddy and highlands

Height Range (in feet)	*Percentage of infection in highlands*	*Percentage of infection in paddy lands*
3,400	42·22 ..	31·1
4,500	69·37 ..	31·52
5,000 to 5,500	36·78 ..	No paddy grown
Above 5,500	0·02 ..	No paddy grown

Keeping in view the information so far available, it is suggested that :

(1) With a view to regulate the movement of seed potatoes in the Island it would be desirable to introduce urgently a " Seed Potato Act " which should make it obligatory on the part of cultivators to grow only such seed potatoes which conform to certain specifications (as laid down by the Deparment of Agriculture) and are duly certified to be fit for use as seed by a competent authority of the Department of Agriculture. As a consequence of this measure it will follow that :

(*a*) It would be the responsibility of the Department of Agriculture to ensure supply of seed stocks, in required quantities, in accordance with the targets to be laid down during the year.

(*b*) Since seed potatoes are produced by the Department of Agriculture only in the high hill regions, movement of seed potatoes will be only in one direction, namely, from higher to the lower elevations.

Besides ensuring health standards of seed stock, the system will create conditions of an internal quarantine and thus prevent possible movement of bacterial wilt from the lower to the higher hill regions.

(c) Restrictions would be imposed on use of seed of imported potatoes (particularly those imported from countries where bacterial wilt is known to be present.)

(d) Seeds Act will ensure that no unauthorised trade in seed potatoes develops in the Island.

Some varieties of potatoes said to be resistant to bacterial wilt disease have been imported by the Research Co-ordinator, Dr. Abeygoonewardena. It is unlikely that results of immediate value will emerge out of trials with these varieties. However, there should be no objection to such investigations provided the investigations are strictly restricted to areas where bacterial wilt is severe. These investigations may result in selection of some material which could be at a later stage, if found necessary, be used as parents for breeding bacterial wilt resistant types.

Fertilization and manuring problem : Potato has to build up yields within a short time of about 90 days. It is also known that much of the fertilizers and nutrients in the soil are removed during the earlier phases of the crop growth. If the crop is to produce economic yields, it is necessary that it should be adequately fertilized and the nutrients should be present in an available form. The necessity of drawing correct fertilizer schedules is, therefore, obvious.

During 1956-58 some fertilizer trials have been carried out at Rahangala, Ambewela and Bopatalawa* (Ponnamperuma, 1958). From the data it would appear that the nutrient status of the hill soils of Ceylon is very variable. This variability is reflected in the varying percentage of organic matter, available nitrogen and phosphorus and also exchangeable bases and potash. The values recorded are as follows :

TABLE VIII

Nutrient status of hill soil in Ceylon

	Rahangala 1956–57	*Ambewela 1956–57*	*Bopatalawa 1957–58*
Organic matter ..	3·10 per cent. ..	17·20 per cent. ..	12·3 per cent.
Nitrogen	0·09 per cent. ..	0·43 per cent. ..	0·32 per cent.
Exchangeable potassium ..	0·10 m.e./100 gm.	0·25 m.e./100 gm.	0·44 m.e./100 gm.
Exchangeable bases ..	0·29 m.e./100 gm.	11·90 m.e./100 gm.	2·51 m.e./100 g.m.
Available P (Truog) ..	48 lb. per/acre ..	116 lb. per/acre	94 lb. per/acre

*Ponnamperuma, F.N. (1958). Response of potato to fertilizers, manure, lime and trace elements. Tropical Agriculturist, Vol. CXIX, No. 2.

With wide range of variability in nutrient level, it is obviously necessary that detailed information on the economic level of fertilization on the cultivators' holdings should be secured. This information will be helpful in drawing up for the use by the Extension Workers, manurial schedules suitable for different areas and varying soil types. While detailed fertilizer trials could be carried out in the farms, I would strongly suggest that the simple fertilizer trials be laid out in the cultivators' holdings.

From the published data it appears that two nutrients, viz., phosphate and nitrogen are by far the most important. Nitrogen invariably gave positive and significant response. It has been reported that phosphates alone in certain types of soils (as at Bopatalawa) showed high responses ; at other places (as at Rahangala) the response was spectacular when a combination of nitrogen and phosphates was used. Moreover, the uptake of nitrogen appears to have been limited in the absence of phosphatic fertilizers. As regards potash, the availability is usually adequate to support the crop. The need of potash in potato fertilization will, therefore, have to be carefully considered.

Another point which is of importance is the use of cattle manure and other forms of organic manure. Very little work has been done in this direction. I have, during my visits, observed several fields where cattle manure when applied has markedly improved the crops. In trials carried out at Ambewela (Ponnamperuma, 1958) significant responses were also observed when cattle manure, at 5 to 10 tons per acre, was applied. There is need to secure detailed information on the use of cattle manure and other forms of organic manures in combinanation with inorganic fertilizers.

Increased nitrogen and potash fertilization of potato crop is sometimes known to decrease the calcium uptake of the plants and the yield response of potato to nitrogen and potash is, in the acid soils, limited beyond a certain level of fertilization. Liming has also been found to help in a greater release of soil phosphorus. Considering the benefits that might accrue through the application of lime to highly acid soils, as has been found by Ponnamperuma (1958), it is desirable to secure more precise information on use of lime in highly acid soils in combination with fertilizers.

Different types of nitrogenous fertilizers have given different yield response particularly in the case of potato crop. Thus, in experiment carried out in India, Sulphate of Ammonia proved to be invariably superior to Urea. It would be desirable to gather information on the relative efficiency of different forms of nitrogenous fertilizers in relation to the potato crop.

Cultural experiment: My visits to cultivators' plots gave me the impression that there is lack of information and appreciation on the use of correct cultural methods in potato culture. The Extension Officers are hardly familiar with the culture of potato and cannot, therefore, be expected to act as guides to the cultivators. The value of certain local practices which are widely adopted by the cultivators is hardly known. Thus, the merits of furrow planting over the planting in flats needs investigation. Similarly the practice of lightly earthing along the sides of the plant (leaving a small furrow in the plant row) can hardly be beneficial. There is no standardized system adopted regarding spacing between rows. Some cultivators plant tubers in a double row, others prefer to sow in a single row. Planting along contours is unknown. The above are only a few examples to show how much remains to be done in securing information on correct cultural practices. Experiments on the following line are likely to yield information of immediate practical value :

1. **Seed size and spacing distances:** These trials may be carried out to secure more precise information on seed rate in relation to spacing distances. In this connection observations of Ariyanayagam, (1958)* that seed rate is of primary factor influencing yields are of interest.

2. **Planting methods**

(1) In furrows (local method), (2) in flats, (3) in low ridges.

The advantage (germination, stand and yield) of different methods should be correlated with rainfall conditions (particularly during the period between planting and germination).

3. **Planting system**

(1) Single row

(2) Double row

This experiment may be combined with spacing distances.

*Ariyanayagam, D.V. (1958). Variety and cultural trials with potato. Tropical Agriculturist, Vol. CXIV, No 2.

4. **Earthing of plant rows:** The following treatments may be adopted:

   (1) Local method of lightly earthing along sides leaving a furrow along the plant row.

   (2) One earthing when plants are about 6 in. high.

   (3) Two earthings, first when plants are 6 in. high (about 3 weeks after planting) and later about 6 weeks after planting.

5. **Use of cut-sprouted seeds versus whole sprouted seed:**

   (1) Cut and immediately planted.

   (2) Cut and suberized for a week or so before planting.

   (3) Whole tubers well sprouted.

   (4) Whole tubers just beginning to sprout.

Equal weight of seed piece should be used in this experiment.

Concluding remarks: The level of yields at present is low. Substantial improvement in yields per acre can be expected with the right choice of varieties, adequate fertilization of the crop and correct methods of its culture. Information of several of these aspects is yet lacking. Suggestions made in this report will help to secure the knowledge and materials needed for the improvement of the Potato Industry in the Island.

SECTION III

EXTENSION, DEVELOPMENT AND MARKETING

A.—Extension and Development

B.—Marketing

EXTENSION, DEVELOPMENT AND MARKETING

A.—EXTENSION AND DEVELOPMENT

The seed distribution programme in the Island was initiated in the middle of 1959, shortly after the establishment of seed farms. For October, 1959, planting seed potatoes produced at the seed farms were distributed to 400 to 500 cultivators over a wide area. Beginning with January, 1960, the tempo of seed distribution increased considerably. Figures for 1959, October-November, planted crop (Table I) show that an average yields of nearly 5½ tons per acre were secured and in certain areas the yield was as high as 7½ tons per acre. Considering that the crop matures in about three months time, the results so far achieved are highly satisfactory.

TABLE I

Average yields on cultivators' fields in October 1959 planted crop*

Name of area	*Acreage planted*	*Yield per acre Tons*	*Cwt.*
Rahangala	2·5 ..	6	2
Kandapola	3·7 ..	7	1
Boralanda	1·3 ..	7	9
Nuwara Eliya	3·3 ..	5	1
Magastota	3·7 ..	3	16
Sita Eliya	1·5 ..	4	8

Average yield per acre : 5 tons 7 cwt.

*The yield figures were supplied to me by Dr. Abeygoonewardena and Mr. Ariyatilaka. Yield records are from an area of 16 acres harvested.

For the second crop, seed was distributed over an area of more than 100 acres during December, 1959, and January-February, 1960. We† inspected a number of fields round about Nuwara Eliya where seed was distributed by the Extension staff. The crops were very healthy even though the seed used for the crops was grown at the farms over three successive generations. December-sown crops were nearing maturity. A few plants dug out in the field yielded about 1½ to 2 pounds of tubers per plant. Great enthusiasm has now spread among the cultivators and potato cultivation in these areas is rapidly gaining ground. With the spectacular success the project has achieved both in Seed Production and its popularisation among the growers, a stage has now

†Dr. Chandraratna, Mr. A. V. Richards and myself.

come when the Department should concentrate its energy on the extension and development aspects of potato culture. With the rapid rate at which the Deparment of Agriculture is achieving its targets, it should be easy to plant about 4,000 acres of commercial crop per season* in another year's time and in any case not later than the middle of 1961. About this time also, Ceylon should be self-sufficient in table potatoes. I must at this stage, therefore, emphasise that it is absolutely necessary to set up immediately an effective organisation which would ensure a planned development of the crop and also provide a service for assembling, grading and marketing of the produce which henceforth will flow into the trade channels regularly. If the organisational aspects mentioned below are not urgently attended to, conditions of confusion and imbalance are likely to arise.

Establishment of a " Supply Service " for any commodity is a matter concerning primarily organisation and administrative fields. However, taking advantage of the experience in the sphere from other countries where similar conditions exist, I would, with due consideration to the local conditions, suggest some measures in the following paragraph. Essentially " Supply Service " in potato will have to undertake :

1. **Seed distribution :** While the Department may be able to handle the distribution of small quantities of seed over a limited area, it is obvious that for distribution of about 5,000 tons of seed per year aimed at, the Department of Agriculture will have to seek help from and enter into a working arrangement with the established trade channels in the country.

2. **Fertilizer supplies :** A well-organised and effective fertilizer programme is necessary for the successful growth of the crop. The organisation handling seed distribution should also be charged with the function of the stocking and supply of various fertilizers. The fertilizers should be distributed as " potato mixture " containing different fertilizers in specified proportions as laid down by the Department of Agriculture.

3. **Fungicides :** As in the case of seeds and fertilizers easy availability of fungicides (needed for crop plant protection services) is also necessary. This aspect could also be handled by the departmental trade agents.

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* There being three seasons in a year about 10,000 to 12,000 crop acres will be raised under commercial conditions during the year.

§Fresh potatoes have already started to flow to the markets of Nuwara Eliya and other nearby towns.

For the "Supply Service" work indicated above it is suggested that :

(1) The Multi-Purpose Co-operative Societies be linked up with the departmental plans and help rendered to them in organising the work in the potato growing areas.

(2) The Extension Unit of Potato Development Project should organise the cultivators into "Potato Growers' Associations" which should be affiliated to the Multi-Purpose Co-operative Societies so that the benefits granted by Co-operative agencies and the Department are easily available to the potato growers through these associations.

(3) As the potato production programme receives momentum and internal supplies are available for marketing, it should be anticipated that the conditions of competitive trade with foreign markets are likely to be created. Such a situation could cripple the young and growing industry. Following further measures would be necessary particularly in the initial stages :

(*a*) Arrangements should be made through the Co-operative for supply of seed, fertilizers and fungicides to the cultivators (now members of the co-operative societies) on a short term loan basis ; the loan to be recovered from the beneficiaries at the time of marketing of their produce. This system would also help economically backward growers of hill areas.

(*b*) The system of price guarantee, as has been instituted for several crops like paddy, chillies, onions, &c., be extended to the potato as well.

The machinery for extension set up by the Department of Agriculture is yet inadequate and inexperienced to discharge the following functions :

(1) Dissemination of technical knowledge among cultivators in matters relating to different aspects of potato production.

(2) Ensuring that seed stocks are made available by the Co-operatives only to such areas which are duly approved by the Department of Agriculture and are suited for potato production. (Here freedom from bacterial wilt in an area is an important consideration.)

(3) Advising and ensuring the cultivations to grow potatoes only during the seasons and periods of low late blight incidence.

(4) Maintaining a pool of Plant Protection Machinery and organising spraying programme in accordance with the schedules to be drawn up for different areas by the Department of Agriculture.

(5) Other miscellaneous work like the maintenance of data on areas under cultivation, yields, market conditions, disease incidence, &c.

In this connection I would like to emphasise that the Extension Organisation to be set up by the Department of Agriculture should work exclusively on the Potato crop. The Potato development should not be dealt with as a routine extension work because:—

(1) Potato culture is a highly specialised job and unless the personnel are acquainted with the crop and possess the needed experience and technical knowledge, they can hardly be effective at the field level. The extension worker without the technical knowledge is often a limitation, rather than an asset, as far as potato crop is concerned.

(2) Potato development work is a full time work. Three crops a year have to be attended to ; besides, the work connected with the seed, fertilizer and fungicidal supply and other marketing and grading problems which are likely to arise.

(3) Potato extension organisation will be limited to a specified hill zone and a small, well-knit unit under local control will be effective.

I have at other places stated that immediate administrative action is necessary to restrict imports of table potatoes by the beginning of 1962. I would emphasise this recommendation once again here.

B.—MARKETING

With the introduction of a system of price guarantee and the supply of seeds, fertilizers and fungicides to the cultivators as recoverable loans, it is obvious that the marketing of the produce should be handled by Multi-Purpose Co-operative Societies set up in the country. It would be necessary for marketing purposes to lay down official standards of grading. This will ensure that prices are paid in accordance with the grade of the produce rather than bulk supplies. Having laid down official standards of grades, it should be possible to advertise the rates under the Market and Price Reporting Services operating in the Island.

In course of time, it will also be necessary for the Department of Agriculture to provide properly designed sheds for assembling and grading of the produce.

SECTION IV

ORGANIZATION OF RESEARCH AND DEVELOPMENT

The Seed Potato Development Section

Research Section

Extension

Training

ORGANIZATION OF RESEARCH AND DEVELOPMENT

Potato research and development, besides, being a specialized job, require a high degree of co-ordination between different phases of activity ; seed production, extension and research problems. The results of value in practical fields can be expected if the potato projects work as a unit under the direct authority of the Director of Agriculture. Suggested organization for research and development is given in appendix.

The potato development project should consist of the following three sections, each under the charge of an experienced and trained officer :

(1) Seed Potato Development Section.
(2) Research Section.
(3) Extension Section.

THE SEED POTATO DEVELOPMENT SECTION

The functions and responsibilities of this section would be :

(i) To organise and execute the work on seed potato production in all its stages.
(ii) To fix, in consultation with the extension unit, quarterly targets of seed potato production and make the same available to the operating extension and supply services.
(iii) To ensure that field inspections of crops are carried out in accordance with the schedules laid down, and to maintain proper records on rate and percentage of degeneration during different crop seasons at the farms.
(iv) To attend to other miscellaneous work connected with soil and crop management at the farms.

A Seed Potato Development Officer should be directly responsible for the work at the foundation and certification farms set up in the Island. Each farm should be under the charge of a local Farm Manager with the necessary subordinate staff.

RESEARCH SECTION

Three Specialists officers with necessary laboratory and field staff would be needed for tackling the several research problems mentioned in the report. The specialists suggested are :

(*a*) One Assistant Botanist, to be in charge of the botanical and varietal aspects of the work.

(*b*) One Assistant Pathologist, to be in charge of the disease aspects. He should also carry out a survey and study of the diseases affecting the potato crop in the Island.

(*c*) One Assistant Agronomist whose function would be mainly to organise and execute research on manurial and cultural aspects.

The three research schemes mentioned above should work directly under a senior officer to be designated as the Potato Research and Development Officer. The Potato Research and Development Officer should be responsible to the Director of Agriculture for execution and co-ordination of the work connected with research, seed production and extension units. The Officer-in-charge of the project (Potato Research and Development Officer) should either be a Botanist or Plant Pathologist with adequate training in crop Botany. In effect, therefore, for the Research Section, besides the Potato Research and Development Officer, two other officers, one in Botany or in Plant Pathology and the other in Agronomy would be required. Later, if the problem of degeneration diseases present difficulties in the maintenance of seed stocks in a healthy state, it might be necessary to provide an additional Virus Pathologist. The need for this officer should be assessed after the seed potato development programme has further progressed and the problems which may present themselves during the course of work fully known. In the meantime, the routine type of virus work connected with virus problems could be carried on by the Assistant Pathologist.

The activities of research should be shifted from Rahangala to Nuwara Eliya which should be headquarters of the Potato Research and Development Officer. The existing system of controlling the organisation and work from Rahangala is not satisfactory. For purposes of research, a specified area at Sita Eliya Farm should be allotted. This area should be, as far as possible, isolated from the main seed potato certification farm. Besides the research plots at Sita Eliya in the hills, a substation should be established in the plains at Jaffna where work connected particularly with the varietal adaptability and manurial investigation should be carried out. An Agricultural Instructor working directly under the Assistant Botanist, would be required for the purpose.

EXTENSION

The extension organisation should work under a senior officer. The Potato Extension Officer should be assisted in his work by a team of field workers (Field Inspectors).

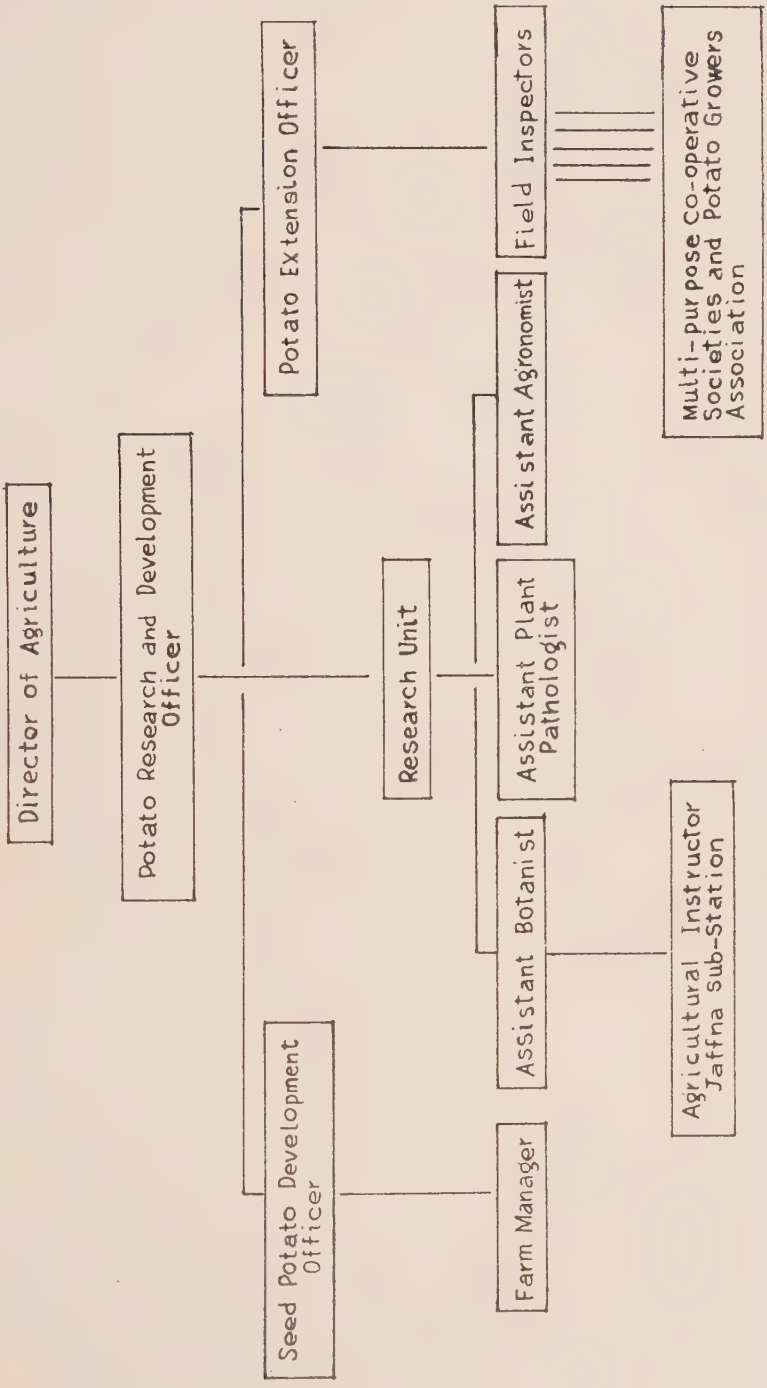
The potato growing area in the Island should be divided into zones and for each zone an adequate number of field workers provided. It is suggested that one field worker may be provided for 400 to 500 crop acres, i.e., about 200 acres of crop in each season. About 20 Field Inspectors would be needed in the first phase of potato development. During the initial stages of work (for the first two years) a large number of field workers may be required, but with times as the field Inspectors gather experience and efficiency one field Inspector should be in a position to look after and manage an area of 200 acres of the crop (with two or three crops per year). It is, therefore, suggested that the large number of field inspectors be employed in the beginning and their number gradually reduced to about twenty or so as the work stabilises.

TRAINING

The problems of potato culture are several and they are intricate. It is essential that the staff employed under the Potato Development Project should be adequately trained. Training of large staff outside the country may not be easy. It is, therefore, suggested that a training course for the personnel to be employed under the project be organised locally. This course need not be long, but it should cover at least one crop season. After the basic course of training is over the Potato Research and Development Officer should organise periodically refresher courses of a week or ten days duration each periodically so that the entire staff employed in the development, research and extension activities gets the benefit of the experience and results secured by the specialists and the officers in charge of seed development and extension work. Such refresher courses should deal mostly with such practical problems as are faced by the field workers during the course of their work.

APPENDIX

ORGANIZATION OF POTATO RESEARCH AND DEVELOPMENT PROJECT



EXPERIMENTS ON THE FUNGICIDAL CONTROL OF LATE BLIGHT OF POTATO

II. Some aspects on improvement of the field control of epiphytotics

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IN the first paper of this series the results of evaluations of fungicides on the control of late blight epiphytotics of potato have been discussed. The present paper deals with experiments on improvement of the efficiency of controlling natural epiphytotics of late blight ; the experiments were planned with the following objectives in view :

1. Reduction in the concentration of the fungicide and decreasing the frequency of spray application.
2. Addition of stickers to the spray to improve the tenacity of the fungicide under conditions of heavy rainfall.
3. Reduction in the quantity of the spray by application to the minimum of plant surface required to obtain economic control of the disease.
4. Search for more economical and effective carbamate fungicides

Experiment I : *Effect of varying dosage of the fungicide and frequency of spray application on the control of late blight*

The trial was conducted at the Livestock Farm, Bopatalawa in the 1957 Yala season. The rainfall was unusually heavy in the test area during the latter stages of the crop, a critical period for the development and spread of *Phytophthora infestans ;* The rainfall recorded during the last 45 days of crop growth was as heavy as 21.25 inches.

The variety Duke of York which is reputed for its extreme susceptibility to late blight infection was planted in furrows to which the following pre-planting manurial and fertilizer mixture had been

added ; sulphate of ammonia, Conc. superphosphate, and muriate of potash in the proportion of 4, $2\frac{1}{2}$ and 1 cwt. per acre and farmyard manure applied at 10 tons to an acre.

The experiment took the form of a randomized block with a plot size of 20′ × 20′ ; the treatments were replicated three times. A commercial fungicide based on zinc ethylene bisdithiocarbamate was applied at dosages of 0.5, 1.0, 1.5 and 2.0 lb. in 100 gallons of water and at frequencies of 3, 6, 9, 12 and 15 days. The method of spray application and disease assessment reported earlier (Abeygunawardena, D. V. W., and Peiris, J. W. L., 1958), were adopted in the present investigation.

The tuber yield and the fungicidal efficacy ratings, meaning the per cent of foliar disease, are shown in table 1.

TABLE I

Effect of dosage of fungicide and frequency of spraying on the extent of foliar disease and tuber yield

Frequency of Spraying in days	*Dosage of fungicides*							
	0·5lb/100 gals.		*1lb/100 gals.*		*1·5lb/100 gals.*		*2lb/100 gals.*	
	Mean% disease	*Yield in tons/acre*	*Mean% disease*	*Yield in tons/acre*	*Mean% disease*	*Yield in tons/acre*	*Mean% disease*	*Yield in tons acre*
3	26·6	1·86	10·3	2·14	2·3	2·69	2·3	3·06
6	88·3	1·67	88·3	1·34	50·0	1·70	50·0	2·12
9	88·3	1·65	95·0	1·33	81·6	1·59	66·6	2·96
12	96·6	1·68	96·6	1·49	95·0	1·63	90·0	1·61
15	96·6	1·36	98·3	1·49	95·0	1·65	96·6	1·66

Unsprayed control—1·36 tons per acre.

The tuber yield is largely dependent upon disease control. The trends for foliar disease and tuber yield are remarkably striking. Maximum disease control and as a consequence maximum yield was obtained with a dosage of 2 lb. of the fungicide in 100 gallons of water giving an increase of about 54 per cent of tuber weight over the unsprayed check plot ; the extents of disease control and tuber yield decreased progressively with the decrease in concentration of the fungicide. The difference between dosages of 1.0 and 0.5 lb. was non significant whereas the dosage of 1.5 lb. was significantly more effective than 1.0 and 0.5 lb. In regard to the frequency of spraying, a three day interval of spraying was distinctly superior to any other longer interval in the case of all dosages except the lowest dosage. With

a 3 day interval of spraying the efficacy of disease control increased with the increase of dosage of the fungicide. Thus, under conditions of the experiment, maximum yield and disease control was obtained with a 3 day frequency of spray application at a dosage of 2 lb. in 100 gallons of water.

Experiment II: *Effect of varying dosage of fungicide and sticker on the extent of Late Blight Control*

Tenacity of the spray deposit is an important factor which determine the field performance of any protective fungicide. In heavy rainfall the fungicide applied to the leaf surface is rapidly leached thereby necessitating the increase in dosage and frequency of spray application. In the present investigation the efficiency of stickers in the fungicidal spray was evaluated to ascertain the suitable quantities of fungicide and sticker which would give maximum disease control.

The fungicide zinc ethylene bisdithiocarbamate and the commercial sticker "Tenac" and "Albolinium" were mixed in varying proportions and sprayed at weekly intervals. The experiment was set down at Rahangala. The design of the trial was of the usual randomized block type replicated 4 times and with a plot size of 15′ × 14′. The variety Great Scot was used and planting was delayed in order to subject the trial to the heavy rains in April. The results are given in Table 2.

TABLE II

Effect of varying dosage of fungicide and sticker on disease control

Dosage of fungicide lbs/100 gals.	*Concentration of sticker*	*Yield in tons per acre Tenac*	*Yield in tons per acre Albolinium*
0	0·2	3·90	2·9
0·5	0·15	4·23	3·94
1·0	0·1	4·70	4·37
1·5	0·05	5·58	4·81
2·0	0·0	5·51	5·86

Unsprayed Control—3·61 tons per acre.

The analysis shows a highly significant linear response. The efficacy of treatment increased progressively with the increase in concentration of the fungicide, the two stickers showing similar trends. The sticker "Tenac" has given a yield of about 10 per cent more than Albolinium.

Experiment III: *Extent and Control of Infection by Phytophthora infestans on Upper and Lower leaf suface of Potato*

Bjorkling K and Sellgren K. A. (1955) reported that in mild attacks of *Phytophthora infestans* there were about 7 or 8 times as many infections on the upper surface as on the lower surface of leaves. The possible control of late blight by coating the upper surface only with the fungicide, thereby reducing the quantity of spray used, was ascertained in a field investigation carried out at Rahangala. The results of the trial are summarised in Table 3.

TABLE III

Effect of leaf surface sprayed on the extent of disease control

Treatment	*%Disease*	*Yield tons/acre*
Upper leaf surface sprayed ..	96 ..	4·68
Both leaf surfaces sprayed ..	72 ..	6·67
Unsprayed check	100 ..	4·12

The treatments gave a yield significantly superior to the unsprayed check. Spraying of both leaf surfaces was significantly superior to spraying the upper leaf surface only, giving an increase in yield of about 25 per cent. Thus, under the conditions of infection by *Phytophthora infestans* obtained in the test area spraying both upper and lower leaf surfaces is an important requirement in late blight control.

Experiment IV: *Relative Efficiency of Dethiocarbamate Fungicides in Controlling Disease*

Preparations approved for the control of *P. infestans* include a group of organic fungicides based on the salts of dithiocarbamic acid which in recent years have become increasingly popular among potato growers. Several workers have reported the efficiency of dithiocarbamate fungicides to control late blight of potato and tomato.—(Chathopadyay S. B. 1952; Callbeck L. C. 1956; Thiede H. 1956). In Ceylon, Abeygunawardena, D. V. W., and Peiris, J. W. L. (1958), demonstrated that under the climatic conditions prevailing at Bopatalawa, the dithiocarbamates were significantly superior to all other organic and inorganic preparations tested; the fungicide based on zinc ethylene bisdithiocarbamate being most effective against late blight. In an attempt to improve disease control by "white sprays" the present investigation was undertaken at Rahangala.

A variety of dithiocarbamate fungicides were screened. Their active ingredients are given below :—

A. 70% manganese ethylene bisdithiocarbamate.
B. 70% manganese ethylene bisdithiocarbamate.
C. 65% zinc ethylene bisdithiocarbamate.
D. 65% zinc ethylene bisdithiocarbamate.
E. 70% zinc ethylene bisdithiocarbamate.
F. 76% zinc ethylene bisdithiocarbamate.
G. zinc ethylene bisdithiocarbamate and copper oxychloride.
H. 76% Ferric dimethyl dithiocarbamate.
I. 76% Ferric dimethyl dithiocarbamate.
J. 19% Disodium ethylene bisdithithiocarbamate.

The method of spray application, disease assessment and cultural operations were similar to those reported earlier. The experiment was statistically set down, all treatments were randomized and replicated 4 times. The individual spray plot was 15′ × 20′. The yield results and spray efficiency data for the different preparations are presented in Table 4.

TABLE IV

Relative efficiency of dithiocarbamate fungicides in controlling late blight

	Fungicide	*Yield tons/acre*
A.	70% manganese ethylene bisdithiocarbamate	7·42
B.	70% manganese ethylene bisdithiocarbamate	6·65
C.	65% zinc ethylene bisdithiocarbamate	6·19
D.	65% zinc ethylene bisdithiocarbamate	5·38
E.	70% zinc ethylene bisdithiocarbamate	5·00
F.	76% zinc ethylene bisdithiocarbamate	6·00
G.	zinc ethylene bisdithiocarbamate and copper oxychloride ..	6·64
H.	76% Ferric dimethyl dithiocarbamate	5·24
I.	76% Ferric dimethyl dithiocarbamate	4·90
J.	19% Disodium ethylene bisdithiocarbamate	4·52
	Control	3·30

Significant difference—0·33 tons per acre.

A study of the data on tuber yield reveal that the preparation A with manganese ethylene bisdithiocarbamate as its active principle out yielded all other treatments and gave an increase in yield of about 2¼ times that of the unsprayed check. The preparation B having the same active principle gave significantly superior yields to most preparations having zinc ethylene bisdithiocarbamate with the exception of the formulation G which is a combination of the zinc ethylene bisdithiocarbamate and copper oxychloride. The formulations having

Ferric dimethyl dithiocarbamate and Disodium ethylene bisdithiocarbamate, although giving comparatively better control than the unsprayed check are of little importance to justify their commercial use against late blight of potato.

DISCUSSION

With an extremely susceptible variety of potato, namely Duke of York, epiphytotics of late blight have been shown to be effectively controlled by the application of increased concentrations of the fungicide at frequent intervals. In corporation of stickers to the fungicidal spray did not reduce the concentration of the fungicide required to give effective control of the disease. The difference in the efficiency of stickers used is demonstrated. The sticker Tenac giving a yield of about 10 per cent more than Albolinium.

Protective spraying of both upper and lower leaf surfaces is a necessary requisite in controlling late blight epiphytotics ; spraying of both leaf surfaces was significantly superior to spraying the upper leaf surface only, giving an increase in yield of about 25 per cent.

The dithiocarbamates differed in their effectiveness on controlling the disease. The manganese ethylene bisdithiocarbamates outyielded all other dithiocarbamates. The formulations containing zinc dithiocarbamates were superior to those with Ferric dimethyl dithiocarbamate and Disodium ethylene bisdithiocarbamate.

ACKNOWLEDGMENT

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METHODS OF POTATO SEED PRODUCTION IN CEYLON

BY

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PRODUCTION and maintenance of pure, disease-free and vigorous potato seed material demands a thorough knowledge of factors influencing yields, directly or indirectly. Cumulative infection of certain virus diseases which tend to cause rapid degeneration and reduction in yield potential of seed material is the most important of these factors. The troublesome virus diseases are chiefly : leaf-roll, leaf-drop streak or virus Y, and potato mottle or virus X. It has been the experience of potato-growers in the temperate countries that seed potato obtained from the cooler northern latitudes is more vigorous than that from the southern latitudes, and the disparity has been attributed to a reduction in the incidence of degeneration of seed potato produced in the northern latitudes. In the tropical and sub-tropical countries certain meteorological and ecological conditions obtaining at high altitudes have been found to favour the production and maintenance of vigorous seed material, and they have been exploited to advantage. As comparable conditions exist in Ceylon's hill country, it is possible to maintain potato seed stocks without an appreciable reduction in yield potential, by the judicious selection of seed areas and by making minor adjustments in agronomic practices.

Bacterial wilt, caused by *Pseudomonal solanacearum*, is perhaps the chief hazard in seed potato production in Ceylon. The bacterium is soil-borne and its growth and parasitic activity are favoured by warm and dry weather conditions. As the bacterium is disseminated through infected seed, it can gain entry into hitherto wilt-free land through the medium of infected seed. Main problems involved in the production locally of disease-free seed potato can be outlined as :

(1) In the absence of direct methods for the control of bacterial wilt, seed production to be confined to wilt-free zones.

(2) Control of virus diseases to conserve the yield potential of seed stocks.

(3) Maintenance of the purity of the varieties.

Production of wilt-free seed

Preliminary trials conducted in *Maha* 1956/57 revealed that while the crop at Rahangala was riddled to some extent with bacterial wilt, the crop raised at Ambawela, Nuwara Eliya and Bopatalawa were refreshingly free of the disease. Based on these results, pilot plots with the following objectives were set down in cultivators' fields at two elevations, viz., 4,200 ft. and 6,200 ft.—

(1) to ascertain the distribution of bacterial wilt at the two elevations.

(2) to determine the effect of the cropping history on the incidence of bacterial wilt.

(3) to test the validity of the popular theory that farmyard manure harbours the bacterium causing wilt disease.

Although inconclusive, the results of these trials brought out the following interesting points:

(1) that bacterial wilt is absent at an elevation of 6,200 ft., (if not introduced).

(2) that the wilt organism does not appear to be transmitted through farmyard manure.

(3) that the wilt disease is present over appreciable extents at the lower elevations, and is particularly severe in plots in which solonaceous crops have been grown.

4. That bacterial wilt is more or less absent in paddy land. These results were of considerable value in the formulation of a 'Potato Seed Production Programme' in Ceylon, one of the aims of which is the production of wilt-free seed material. Hence, it was considered worthwhile to extend these trials over a wider range in the potential potato growing areas in order to be able to determine the soils free of *Pseudomonas solanacearum* and thus demarcate areas suitable for seed production.

Confirmation of the above-mentioned results was sought by setting down a total of 121 trials in cultivators' fields during *Yala* 1957. For this purpose, the probable cultivators in Nuwara Eliya and Badulla

districts were grouped into three categories according to elevation with the assistance of the Agricultural Extension Officers, and the elevation strata were as follows :

(*a*) 3,000 to 4,000 feet.
(*b*) 4,000 to 5,000 feet.
(*c*) 5,000 feet and above.

Cultivators in each elevation stratum were selected in a random manner so as to include a minimum of one trial in paddy land and one in highland in each village within a Headman's division. As there is no paddy land in the elevation stratum 5,000 feet and over, all plots at this elevation were on highland. Certified seed potatoes of the variety Tedria were planted in plots 20 feet × 40 feet and one half of each such plot was fertilised with a mixture of sulphate of ammonia, concentrated superphosphate and muriate of potash in the proportions 4, 2½ and 1 cwt., per acre, respectively. The other half of each plot received the same fertilizer mixture at the same rate and also received farmyard manure at the rate of 10 tons per acre, applied in the furrows. Seed tubers were planted at a spacing of one foot within the row and the rows were spaced two feet apart. All trial plots received a routine protective spray of a copper fungicide as a measure against the incidence of late-blight. Records on bacterial wilt and other soil-borne diseases, aphid infestation, virus diseases etc., were taken at weekly intervals. Data on bacterial wilt are summarised in Table 1, and the other relevant data are discussed in this article.

TABLE I

Effect of elevation, nature of land of farmyard manure on the incidence of bacterial wilt

Elevation	*Nature of land*	*Mean percent bacterial wilt*	
		without f. y. m	*with f. y. m.*
Badulla District			
3,000′-4,000′	Paddy land	39·33	40·23
	Highland	46·20	53·30
4,000 -5,000′	Paddy land	29·40	26·80
	Highland	75·90	67·20
Above 5,000′	Paddy land	no trials	no trials
	Highland	20·06	44·00
Nuwara Eliya District			
3,000′-4,000′	Paddy land	18·80	26·10
	Highland	33·20	36·20
4,000′-5,000′	Paddy land	39·60	33·30
	Highland	49·10	45·30
Above 5,000′	Paddy land	no trials	no trials
	Highland	0	0

Trials in the Badulla district grouped under the elevation stratum of 5,000 ft. and above were all located at an elevation of less than 5,500 ft., while all except one in the corresponding elevation stratum in the Nuwara Eliya district were located over 5,500 ft. The results of these trials are summarised below, and they confirm the observations made from the preliminary trials conducted in *Maha* 1956/57.

1. There is a significant difference in the incidence and distribution of bacterial wilt in Nuwara Eliya and Badulla districts, the later district recording more than twice that of Nuwara Eliya district. The mean percentage of bacterial wilt in the two districts is as given below :

	Nuwara Eliya District	*Badulla District*	*Significant difference*
Mean per cent bacterial wilt ..	26 ..	57 ..	1·1

2. Paddy land is not totally free of bacterial wilt infection, the trend, however, being that the incidence of infection is less in paddy land than in highland. There is a highly significant difference in the two types of land in relation to the occurrence of bacterial wilt, plants grown in highland being over 50 per cent more susceptible than those grown on paddy land. The mean percentage of wilt disease on the two types of land is as shown below :

	Paddy land	*Highland*	*Significant difference*
Mean per cent bacterial wilt ..	32 ..	55 ..	1·5

P. Solanacearum is known to be aerobic, and it is, therefore, likely that the anaerobic conditions that obtain in paddy land over the greater part of the year are unfavourable for the survival and multiplication of the bacterium.

3. There is a highly significant difference in the distribution of the wilt disease in the different elevation strata. As shown below, there is about 50 per cent more incidence in the elevation stratum 4000′ to 5000′ than in the lower stratum of 3000′ to 4000′. The higher incidence of the disease in the 4000′ to 5000′ stratum may be due to the fact that the cultivators' holdings in this elevation stratum are extensively cropped with solanaceous crops, particularly tomato, which are alternate hosts of the disease organism.

	Elevation Stratum		*Significant difference*
	3,000′-4,000′	*4,000′-5,000′*	
Mean per cent bacterial wilt ..	37·5 ..	57·4 ..	1·1

The 5,000 ft. and over elevation stratum is not included in the analysis as there is no incidence recorded in the Nuwara Eliya district. Areas over 5,000 ft. in the Nuwara Eliya district will constitute the ' wilt-free ' zone, and therefore, the potential seed producing regions in Ceylon.

4. The application of farmyard manure made no significant difference in the incidence of bacterial wilt. There is no distinction in the incidence of wilt in plots that received the fertilizer mixture only and those that received the farmyard manure in addition to the fertilizer mixture. This confirms the view that the wilt organism is not transmitted in farmyard manure.

Other soil-borne diseases

The following bacterial and fungus diseases were also found to affect the potato crop in the hill country—Collar-rot, caused by *Fusarium spp., Rhizoctonia solani* and *Sclerotium rolfsii*, and Black-leg, caused by *Erwinia atroseptica*. The occurrence and distribution of these pathogens in the different elevation strata are shown in table 2. Diseases caused by the above mentioned bacterial and fungal pathogens appear to be not too troublesome, and if their spread is arrested in time, they may not present a serious threat to potato cultivation in the hill country.

Degeneration of Potato Seed Material

Degeneration of potato seed material is caused by a number of virus diseases, and leaf-roll, virus Y and virus X appear to play a major role. Leaf-roll and virus Y are transmitted by aphids colonising the potato plants, and virus X is spread mechanically.

As it is necessary that seed areas should be reasonably free of the aphids that transmit the leaf-roll virus and virus Y, colonisation of potato plants by the aphids was studied in the preliminary trials and in the subsequent trials conducted on a large scale. In the latter case, the strong winds experienced during *Yala* in the hill country were found to be unfavourable for aphid colonisation, and the aphid numbers recorded were negligible. Data on aphid colonisation and incidence of virus diseases were recorded at regular intervals and the results are tabulated in table 3.

TABLE III

Effect of elevation on colonisation of aphids on potato

Elevation	*Aphid population mean, per leaf*			*Mean % leaf-roll detected*	
	Upper leaf	*middle leaf*	*lower leaf*	*Primary*	*Secondary*
6,200 ft. ..	1·3 ..	1·7 ..	1·2 ..	0 ..	0·9
4,200 ft. ..	1·7 ..	5·9 ..	5·5 ..	0 ..	0

The results indicate that aphid colonisation on potato plants is more in the lower elevation, the warm, dry weather conditions obtaining at such elevations being favourable to the aphids. It is possible that the cold and humid climate of the higher regions is unfavourable to the survival and spread of the aphids. Specimens of aphids collected from potato plants in the course of these trials were identified as *Myzus persicae*, a well known efficient vector of potato viruses.

Although primary leaf-roll was not encountered in any of the trials, secondary leaf-roll was readily recognisable at the higher elevations. This is attributable to the clearer expression of leaf-roll symptoms in the higher colder elevation.

Detection of Potato Viruses

Leaf-roll and virus X have been detected in imported seed stocks. As the leaf-roll virus exhibits very clear symptoms at the higher elevations, it can be detected visually. This facilitates rogueing, (or the removal of diseased plants from crops grown for seed purposes). Virus X which is often symptomless, is detected by serological methods. For this purpose sap from suspected plants is injected into rabbits and antisera is prepared employing standard serological methods. When a drop of diluted antiserum is mixed with the sap from an infected plant, a distinct flocculation reaction takes place. Hence this method can be employed for eliminating virus X from nucleus and foundation seed stocks. Locally prepared antiserum was compared with a sample of antiserum obtained from the Rothamstead Experiment Station (through the courtesy of Dr. P. H. Gregory) and the reactions have been identical.

Maintenance of purity of potato varieties

Potato varieties multiplied for seed production on a commercial scale are distributed as follows :—

Foundation Seed Farm : Pidurutalagala—variety : Tedria.

Foundation Seed Farm : Uda Radella—variety : Gineke.

The varieties are distinguished by the colour of the tubers, and this factor facilitates maintenance of purity. Each seed multiplication farm will specialise in the production of only one variety. Hence, maintenance of purity can be ensured by the isolation of potato varieties and by judicious rogueing of all suspected off-types.

SCHEME FOR SEED PRODUCTION AND RECOMMENDED DIRECTIONS OF SEED MOVEMENT

FIGURE 1 indicates the scheme for potato seed production and the desired directions of seed movement.

It is proposed to maintain virus-free nucleus seed stocks of the commercially propagated varieties, under insect proof conditions, at the Central Potato Research Station, Nuwara Eliya. The nucleus stock will be progressively multiplied and moved to the foundation seed farms for further multiplication. At both these stages extreme precautions are necessary to eliminate the virus diseases and thus arrest degeneration in yield potential. Foundation seed will be multiplied at the seed farms for issue to cultivators as certified seed potatoes.

Summary

The following conclusions based on the data gathered from the studies discussed in this article are noteworthy :—

1. Climatic conditions at the higher elevations are relatively less favourable for aphid colonisation. Therefore, the incidence of virus spread and degeneration will be less at the higher elevations.
2. Bacterial wilt is absent at the higher elevations.
3. The various soil-borne diseases affecting the potato crop are unimportant.

On the basis of the above conclusions, the recommended movement of seed is from higher to lower elevations. Seed should not be moved from lower to higher elevations under any circumstances, as such movement of seed will result in the introduction of both the degenerative and the soil-borne diseases into the " disease-free zone ".

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TABLE II

Effect of elevation, nature of land and farmyard manure on the incidence of soil-borne diseases affecting potato

Badulla District

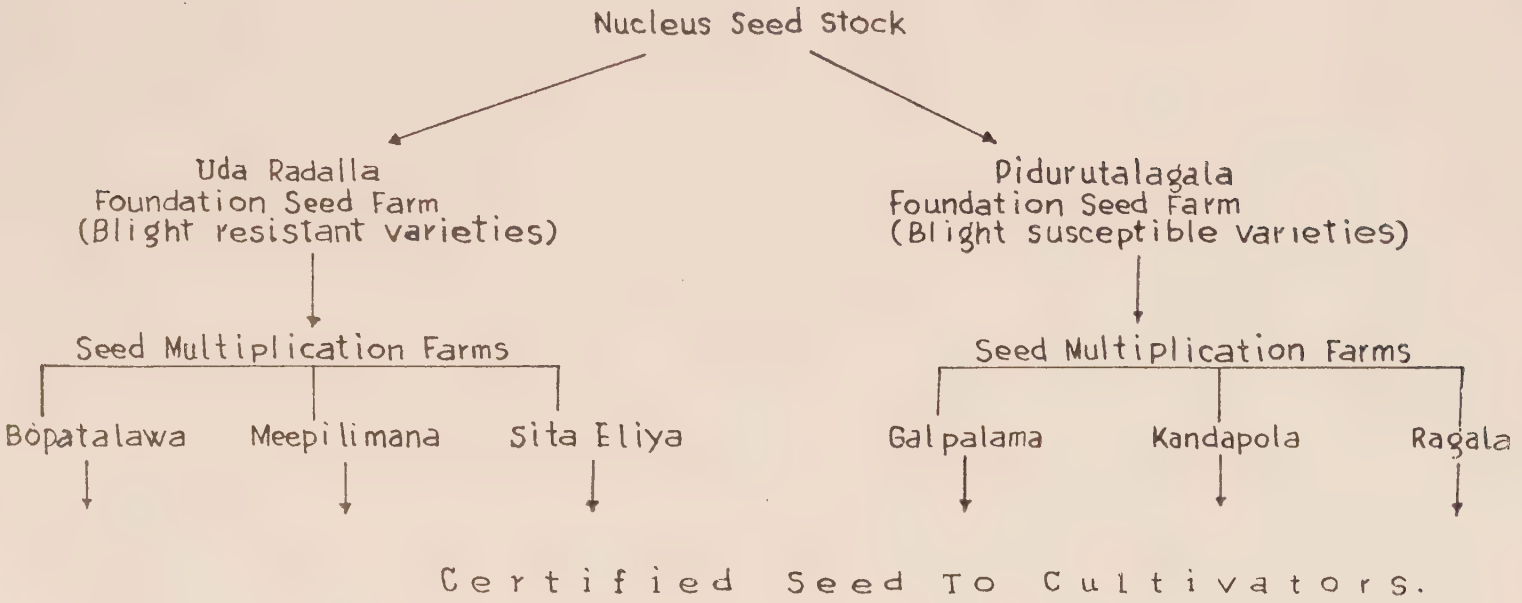
Elevation	*Nature of land*	*without farmyard manure* — mean percent disease				*with farmyard manure* — mean percent disease			
		Fusarium sp.	*Sclerotium rolfsil*	*Rhizoctonia solani*	*Black-leg*	*Fusarium sp.*	*Sclerotium rolfsil*	*Rhizoctonia solani*	*Black-leg*
3,000′-4,000′	Paddy land	0	0	0	0	0	0	0	0
	Highland	0	0	0·1	0	0	0	0·4	0
4,000′-5,000′	Paddy land	0	0	0	0	0	0	0	0
	Highland	0	0	0	0·5	0	0	0	0·6
Above 5,000′	Highland	0	3·0	0	1·0	0	0·4	0	1·1

Nuwara Eliya District

Elevation	*Nature of land*	*without farmyard manure* — mean percent disease				*with farmyard manure* — mean percent disease			
		Fusarium sp.	*Sclerotium rolfsil*	*Rhizoctonia solani*	*Black-leg*	*Fusarium sp.*	*Sclerotium rolfsil*	*Rhizoctonia solani*	*Black-leg*
3,000′-4,000′	Paddy land	2·0	0·4	3·0	2·0	1·0	1·0	5·0	4·0
	Highland	0	0·3	0·1	3·0	0	0·2	0·6	4·0
4,000′-5,000′	Paddy land	0	0	0	0	0	0·1	0	0
	Highland	0	0	0	0·5	0	0	0	0·4
Above 5,000′	Highland	0	0	0	0	0	0	0	0

Figure 1

Scheme for Potato Seed Production and Seed Movement



METEOROLOGICAL REPORT

SUMMARY FOR APRIL-JUNE, 1960

DURING April inter-monsoon conditions prevailed over the Island causing fairly widespread thundershowers in the afternoons and evenings. The greater monthly totals of rainfall which exceeded 20 inches occurred in the western low-country while the lowest totals (totals less than 5 inches) were recorded in the northern, eastern and south-eastern coastal belts. Over most of the Island, rainfall was above normal with the larger excesses (over 10 inches) occurring in the western low-country. The bigger deficits (deficits over 5 inches) were recorded in Dolosbage. There were 6 daily falls over 5 inches, 6.8 inches at Liniyagala Group (Deraniyagala) on the 14th being the highest.

South-west monsoon conditions were evident over the Island during the first few days of May and the monsoon established itself towards the latter part of the 1st week. Rain was experienced in the south-west quarter as well as in places in the north and east till the 25th. Unsettled conditions in the neighbourhood of the Island caused fairly heavy falls in the east and north-east on the 9th and 10th and in the south-west on the 12th and 14th. From the 26th, rainfall was confined to the south-west quarter and central hills. The highest monthly totals of rainfall occurred in the south-west, a few places receiving over 20 inches of rain. Least rainfall, where the monthly totals were below 2 inches, was experienced mainly in the Jaffna Peninsula, Mannar District and in the extreme south-eastern portion of the Island. The rainfall was mainly below normal. The larger deficits (values over 10 inches) were recorded in the south-west and excesses ranging from 5 to 10 inches in the west central coastal area and in the east. There were about 7 daily falls over 5 inches, 8.23 inches at St. Joseph's College Farm, Kelaniya, on the 14th being the highest.

During June normal monsoon weather prevailed with rain confined, practically throughout the month, to the south-west quarter. A temporary surge in the monsoon on the 11th. resulted in fairly heavy rain at a few places in the south-west. On the 14th. and 15th. the monsoon stream became shallow giving rise to a few evening thunder-showers among and to the east of the Central hills with scattered

monsoon showers in the south-west. On the 16th. weather conditions became unsettled over the Island causing fairly widespread rain with very heavy falls (over 5 inches) in south-west, mid-country. Greater monthly totals of rainfall (totals over 20 inches) were recorded in the Kegalle and Kandy Districts. Rainfall was of the order of 5 inches in the south-western coastal areas, while outside the south-west quarter the totals were below 2 inches practically everywhere. Over 40 stations received no rain at all. Rainfall, for the month, was generally below normal. The larger deficits (those over 10 inches) occurred in the south-west. There were about 10 daily falls over 5 inches, 9.29 inches at Pindeniya on the 16th being the highest.

D. J. JAYASINGHE,
Acting Director.

Department of Meteorology,
Bullers Road,
Colombo 7, 8th August, 1960.

Meteorological Report

	APRIL								
	Temperature				Humidity		Rainfall		
	Mean Minimum	Offset	Mean Minimum	Offset	Day	Night (from Min. Temps.)	Total	Offset	No. of Days
Anuradhapura ..	91·8	+0·1	74·1	—0·3	73	95	5·26	—1·17	15
Badulla ..	85·2	+1·0	66·0	—0·2	77	95	10·13	+3·13	21
Batticaloa ..	87·8	—0·1	76·9	+0·2	78	91	4·11	+1·81	8
Colombo ..	88·2	+0·4	74·8	—0·1	73	90	7·81	—1·26	24
Diyatalawa ..	79·4	+1·4	60·3	—0·3	77	94	8·99	+2·45	21
Galle ..	87·4	+1·3	76·8	+0·1	75	86	9·79	+1·08	18
Hambantota ..	87·8	+0·2	76·4	+0·1	74	88	2·63	—1·23	6
Jaffna ..	89·0	—0·6	79·6	—0·6	77	89	3·06	—0·83	12
Kandy ..	87·3	—0·4	69·5	—0·4	71	92	9·58	+3·58	18
Kankesanturai ..	90·3	—1·2	77·8	—0·8	76	95	2·43	+0·89	8
Kurunegala ..	91·6	+0·7	74·1	—0·5	71	95	11·63	+1·72	18
M'Illuppallama ..	91·3	0	73·4	—0·5	73	93	15·96	+8·72	15
Mannar ..	90·3	—0·1	77·5	—0·5	77	91	3·81	+0·39	15
Nuwara Eliya ..	72·1	+0·9	50·9	+1·0	75	87	7·12	+2·14	20
Puttalam ..	90·0	+0·7	74·8	—1·3	72	90	8·02	+3·14	17
Ratmalana ..	89·5	+1·5	75·2	—0·4	71	93	5·96	—4·61	18
Ratnapura ..	91·8	+0·6	73·1	—0·7	71	90	13·13	+1·56	20
Talawakele ..	75·4	—2·1	57·6	—0·2	80	88	8·98	—0·43	19
Trincomalee ..	89·2	—0·1	77·5	—0·2	72	86	2·60	—0·47	9
Mullaitivu ..	88·8	—	76·3	—	78	93	5·06	+2·54	7
Vavuniya ..	91·5	—	73·5	—	72	93	5·85	+1·10	15
Katunayake ..	88·8	—	75·1	—	77	93	15·96	—	21

MAY

	Temperature				Humidity		Rainfall		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Min. Temps.)	Total	Offset	No. of Days
Anuradhapura ..	88·5	—2·4	75·7	—0·7	75	91	2·52	—1·02	15
Badulla ..	85·2	—0·4	67·8	+1·4	72	92	7·60	+2·91	13
Batticaloa ..	90·8	+0·4	78·0	+0·2	70	84	1·14	—0·65	9
Colombo	86·2	—0·7	76·7	—1·0	75	84	14·05	—1·44	26
Diyatalawa ..	77·4	—1·4	64·6	+2·6	71	82	6·41	+0·35	13
Galle ..	84·4	—0·5	77·6	—0·5	81	84	6·95	—5·72	24
Hambantota ..	87·5	+0·7	77·7	+0·1	75	86	1·80	—2·47	15
Jaffna ..	87·3	—0·8	80·9	—0·8	79	85	0·97	—1·03	6
Kandy ..	82·6	—3·3	71·9	+1·3	73	83	5·64	—0·87	23
Kankesanturai ..	90·5	—1·3	79·6	—1·8	75	89	1·27	—0·22	11
Kurunegala ..	87·3	—1·8	76·2	+0·1	76	91	5·60	—1·95	21
M'Illuppallama ..	87·9	—2·9	75·2	—1·2	73	88	3·49	—0·69	14
Mannar ..	89·0	—0·5	79·6	—1·2	78	87	1·08	—0·71	6
Nuwara Eliya ..	66·5	—3·8	57·2	+3·8	80	83	6·94	—1·53	25
Puttalam ..	87·2	—1·2	77·9	—1·0	74	84	5·82	+2·05	17
Ratmalana ..	87·1	—0·2	77·6	—0·4	74	84	16·32	—0·09	26
Ratnapura ..	86·8	—2·2	74·7	—0·2	75	90	12·85	—8·06	30
Talawakele ..	71·7	—3·8	60·9	+1·2	83	94	9·33	—0·08	—
Trincomalee ..	91·1	—1·3	78·6	—0·2	65	80	2·23	—1·00	6
Mullaitivu ..	90·1	—	77·6	—	73	89	4·11	+2·23	9
Vavuniya ..	88·9	—	75·4	—	70	88	3·56	—0·20	13
Katunayake ..	86·9	—	77·0	—	80	91	14·88	—	26

JUNE

	Temperature				Humidity		Rainfall		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Min. Temps.)	Total	Offset	No. of Days
Anuradhapura ..	91·3	+1·3	76·4	0	65	88	0·22	—0·51	1
Badulla ..	87·5	+2·1	64·4	—1·0	64	94	0·36	—1·18	5
Batticaloa ..	93·7	+1·4	77·6	—0·1	62	78	1·77	+0·88	4
Colombo ..	85·6	+0·3	78·2	+0·9	75	82	4·96	—3·70	17
Diyatalawa ..	78·5	+0·9	62·6	—0·6	62	78	2·38	+0·42	6
Galle ..	83·7	—0·2	78·3	+1·1	80	84	4·53	—3·91	21
Hambantota ..	87·8	+1·5	78·1	+1·3	73	84	0·80	—1·31	5
Jaffna ..	86·6	—0·1	81·2	+0·3	80	85	0·09	—0·30	2
Kandy ..	81·6	—0·5	71·1	—2·0	72	85	4·82	—2·48	19
Kankesanturai ..	91·4	+0·4	81·0	+0·4	71	85	0·21	—0·36	1
Kurunegala ..	86·6	+0·1	76·2	+0·6	76	91	7·76	+0·97	19
M'Illuppallama ..	88·7	—1·4	76·6	+0·5	66	84	0·34	—0·99	3
Mannar ..	88·0	—0·1	90·6	0	80	87	0	—0·36	Nil
Nuwara Eliya ..	66·7	+1·1	56·6	+0·9	79	80	5·11	—5·32	23
Puttalam ..	87·3	+0·8	79·6	+0·4	71	78	0·18	—1·22	1
Ratmalana ..	85·7	+1·3	79·2	+1·8	74	82	4·22	—4·76	18
Ratnapura ..	87·4	+0·7	74·7	0	73	88	16·25	—2·30	26
Talawakelle ..	69·8	—0·9	60·4	0	82	91	8·52	—4·76	27
Trincomalee ..	94·0	+1·7	79·6	+0·5	56	76	0·13	—0·80	2
Mullaitivu ..	93·6	—	78·3	—	62	86	0·07	—1·71	1
Vavuniya ..	91·1	—	76·1	—	59	84	0·03	—0·85	1
Katunayake ..	85·8	—	78·6	—	81	86	4·80	—	15

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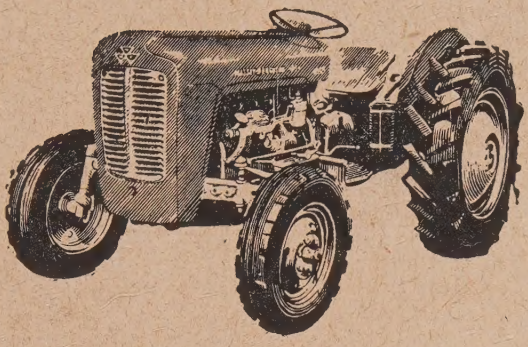

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